Notice No. 4

Rules and Regulations for the Classification of Naval Ships, January 2014

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Issue date: December 2014

Amendments to	Effective date
Volume 2, Part 1, Chapter 1, Sections 1, 3, 4 & 5	1 January 2015
Volume 2, Part 1, Chapter 2, Section 3, 4, 5, 18 & 19	1 January 2015
Volume 2, Part 1, Chapter 4, Section 1	1 January 2015
Volume 2, Part 1, Chapter 5, Section 1	1 January 2015
Volume 2, Part 2, Chapter 1, Sections 2, 6, 7, 8 , 9 & 15	1 January 2015
Volume 2, Part 2, Chapter 2, Sections 1, 5 & 9	1 January 2015
Volume 2, Part 2, Chapter 3, Sections 2 & 7	1 January 2015
Volume 2, Part 3, Chapter 1, Sections 2, 3 & 5	1 January 2015
Volume 2, Part 3, Chapter 2, Section 3	1 January 2015
Volume 2, Part 4, Chapter 1, Sections 2, 3 & 5	1 January 2015
Volume 2, Part 4, Chapter 2, Section 2	1 January 2015
Volume 2, Part 4, Chapter 3, Section 2	1 January 2015
Volume 2, Part 4, Chapter 4, Sections 1, 2 & 3	1 January 2015
Volume 2, Part 4, Chapter 5, New Section	1 January 2015
Volume 2, Part 5, Chapter 1, Sections 1 & 2	1 January 2015
Volume 2, Part 5, Chapter 2, Section 2	1 January 2015
Volume 2, Part 5, Chapter 3, Section 2	1 January 2015
Volume 2, Part 5, Chapter 4, Section 2	1 January 2015
Volume 2, Part 6, Chapter 1, Sections 1, 2, 5, 7, & 9	1 January 2015
Volume 2, Part 7, Chapter 1, Sections 2, 3, 4, 5, 11, 13 & 18	1 January 2015
Volume 2, Part 7, Chapter 2, Sections 1, 9 & 10	1 January 2015
Volume 2, Part 7, Chapter 3, Sections 1, 2, 3, 4, 8 & 11	1 January 2015
Volume 2, Part 7, Chapter 4, Sections 1 & 2	1 January 2015
Volume 2, Part 7, Chapter 5, Sections 1, 2, 3, 5, 6, 7, 8, 9, 10 & 11	1 January 2015
Volume 2, Part 8, Chapter 1, Sections 1 & 16	1 January 2015
Volume 2, Part 9, Chapter 1, Sections 1, 2, 3, 4, 5, 6, & 7	1 January 2015

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Notice No. 4 Continued

Issue date: December 2014

Amendments to	Effective date
Volume 2, Part 10, Chapter 1, Sections 1 to 22	1 January 2015
Volume 2, Part 11, Chapter 1, Sections 1, 2, 3 & 5	1 January 2015
Volume 2, Part 11, Chapter 2, Sections 1, 2, 3 & 5	1 January 2015
Volume 2, Part 11, Chatpter 3, Sections 1, 2 & 6	1 January 2015
Volume 2, Part 12, Chapter 1, Section 9	1 January 2015

Due to the volume of cross references to this Notice, a separate Notice, 4A, will be issued.

Volume 2, Part 1, Chapter 1

General Requirements for Classification of Engineering Systems

Effective Date 1 January 2015

■ *Section 1*
Scope

1.1 Application

~~*1.1.2* The requirements are applicable to mechanical, electrical, control, piping and pressure plant systems.~~

~~*1.1.3*~~ *1.1.2* For the purposes of these Rules, an engineering system is considered to be a ~~series of elements, including all equipment and associated sub-systems necessary to provide specified functions within the intended context of use in the system. Typical sub- systems include associated control and monitoring arrangements and their user interfaces, data communications, power supplies (electrical, hydraulic or pneumatic), fuel, lubricating, cooling, etc~~ combination of interacting elements (sub-systems, equipment, components, hardware, software), organised to achieve one or more of the purposes stated in the Concept of Operations or the System Operational Concept documents.

1.1.3 These Rules are to be applied with reference to the operational conditions defined in the Concept of Operations, *see* Pt 1, Ch 2, 2.2.

■ *Section 3*
Engineering system designation

Existing paragraphs Pt 10, Ch 1, 1.6.1 *to* 1.6.3 *have been renumbered* Pt 1, Ch 1, 3.1.5 *to* 3.1.7.

Existing paragraph Pt 1, Ch 1, 3.1.5 *has been deleted*.

3.1 Categories

3.1.1 For the purpose of classification, an Engineering System is defined as any system that may be installed in a ship where such a system comprises one or more sub-systems or components. For the purpose of determining the appropriate assessment process for engineering systems in naval ships, there are three categories:

(a) Mobility.
(b) Ship Type.
(c) Ancillary.

(*Part only shown*)
~~*1.6.1*~~ *3.1.5* Essential services are those necessary for the propulsion and safety of the ship within the Mobility ~~category~~ and Ship Type ~~category~~ categories ~~(see Pt 1, Ch 1,3)~~ defined in 3.1.2 and 3.1.3 and include but are not limited to the following:

- air compressors for oil engines;
- air pumps;
- automatic sprinkler systems;
- ballast pumps;
- bilge and dewatering system pumps;
- circulating and cooling water pumps;
- communication systems;
- condenser circulating pumps;
- electric propulsion equipment;
- electric starting systems for oil engines;
- extraction pumps;
- fans for forced draught to boilers;
- feed water pumps;
- fire detection and alarm systems;
- fuel valve cooling pumps;
- hydraulic pumps for controllable pitch propellers and those serving essential services here listed that would otherwise be directly electrically driven;
- lubricating oil pumps;
- lighting systems for those parts of the ship normally accessible to and used by personnel;
- made and clean water equipment;
- navigational aids ~~where required by the Naval Authority~~;
- navigation lights and special purpose lights ~~where required by the Naval Authority~~;
- oil fuel pumps and oil fuel burning units;
- oil separators;
- pumps for fire-extinguishing systems;
- scavenge blowers;
- steam raising plant, where steam is required for other essential services;
- steering gear;
- ~~thrusters for dynamic positioning;~~
- valves which are required to be remotely operated;
- ventilating fans for engine and boiler rooms;
- watertight doors, shell doors and other electrical operated closing appliances;
- windlasses;
- power sources and supply systems for supplying the above services.

Essential military systems and damage control arrangements relating to the Ship Type are to be stated where applicable.

~~*1.6.2*~~ *3.1.6* Services such as the following are considered necessary for minimum comfortable conditions of habitability:

- cooking;
- heating and cooling;
- domestic refrigeration;
- mechanical ventilation;
- sanitary and fresh water.

~~*1.6.3*~~ *3.1.7* Services such as the following, which are additional to those in ~~1.6.1~~ 3.1.5 and ~~1.6.2~~ 3.1.6, are considered necessary to maintain the ship in a normal sea-going operational and habitable condition:

- hotel services, other than those required for habitable conditions;
- thrusters~~, other than those for dynamic positioning~~.

■ *Section 4*
Engineering system classification principles

4.1 Classification principles

4.1.1 Engineering system classification principles apply to all systems, equipment and components in order to achieve the provisions of classification. There are five groups of principles:
(a) Design principles.
(b) Construction principles.
(c) Installation, integration and test principles.
(d) Trials principles.
(e) Through life operation principles.

4.2 Design principles

4.2.1 Systems are to be designed, constructed and installed to minimise ~~danger to persons on board.~~ the risk of:
(a) harm to personnel
(b) damage to the platform
(c) damage to the environment

4.2.3 Systems or components to be integrated into a higher level system are to be designed such that all their interfaces, electrical, mechanical, software or environmental, are clearly defined and compatible.

4.2.4 System integration is to be managed by a single designated party, and is to be carried out in accordance with a defined procedure identifying the roles, responsibilities and requirements for all parties involved. This procedure is to identify validation and verification activities to be undertaken and is to be submitted for consideration.

~~*4.2.3*~~ *4.2.5* Systems are to be designed for the ~~defined~~ operating conditions defined in the Concept of Operations, *see* Pt 1, Ch 2, 2.2, that are to include static and dynamic loads.

Existing paragraphs 4.2.4 *to* 4.2.11 *have been renumbered* 4.2.6 *to* 4.2.13.

~~*4.2.12* Systems are to be designed and installed to reduce the risk of fire to a level that is as low as reasonably practicable.~~

~~*4.2.13* Systems are to be designed and installed to reduce the risk of pollution to a level that is as low as reasonably practicable.~~

4.3 Construction principles

4.3.1 The place of construction is to have suitable facilities for the construction, integration and testing of engineering equipment and systems.

4.3.4 Materials are to be approved ~~and~~, manufactured and tested in accordance with a standard acceptable to LR.

4.4 Installation, integration and test principles

4.4.1 Installation and integration ~~is~~ are to be carried out in accordance with ~~plans~~ documentation approved by LR and relevant LR requirements.

4.4.2 Installation and integration ~~is~~ are to be carried out under LR Survey.

4.4.4 Integration tests are to verify that the integrated sub-systems and components operate correctly at the higher system level.

~~*4.4.4*~~ *4.4.5* Any alterations to approved ~~plans~~ documentation are to be approved by LR.

~~*4.4.5*~~ *4.4.6* Surveyable items not complying with approved ~~plans~~ documentation or LR requirements are to be replaced or rectified.

4.5 Trials principles

4.5.1 A trials schedule is to be agreed between the Builder, ~~Naval Authority~~ Naval Administration and LR and is to address LR Rule requirements.

■ *Section 5*
Acceptance criteria

5.2 Military systems guidance

5.2.1 Where military systems are to be installed in accordance with ~~Naval Authority requirements~~ a specified standard and the guidance within these Rules, the assessment process will be in accordance with the requirements for systems within the Ancillary category in Table 1.5.1 and as detailed in 5.2.2 to 5.2.4.

5.2.2 ~~LR design review will assess the~~ The proposed arrangements for compliance with Naval ~~Authority~~ Administration requirements, the ~~design statement~~ System Design Description, Rule guidance and any applicable Rule requirement where the system interfaces with the provisions of classification are to be assessed at a design review. This may be an LR specific design review or LR attendance at a design review organised by the Owner or Naval Administration.

5.2.4 Survey during service will be subject to agreement between LR and the Owner~~/Operator~~ for individual installations.

(*Part only shown*)

Table 1.5.1 Assessment process for engineering systems

SYSTEM PROCESS	MOBILITY CATEGORY	SHIP TYPE CATEGORY	ANCILLARY CATEGORY
DESIGN REVIEW	• Plans of all systems are to be appraised by LR • Procedure for component approval is to be agreed between the producer and LR • Procedure for component approval is to be agreed	• Plans to be appraised by LR when required by the Rules and where additional optional Class notation(s) are requested by Owners or Naval Administration	• Plans of system arrangements are to be reviewed by LR • Design review by LR where required by the Rules
IN SERVICE	• Subject to survey by the Rules or Regulations	• Subject to survey where required by the Rules or Regulations or requested by Owners or ~~Naval Authority~~ Naval Administration	• No requirements unless required

Volume 2, Part 1, Chapter ~~2~~ 3

Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

Effective Date 1 January 2015

Chapter 2 has been renumbered Chapter 3 and all references have been amended.

■ *Section 1*
Scope

1.1 Application

1.1.2 ~~Detailed and additional requirements for control engineering and electrical engineering systems are contained in Part 9 and Part 10 respectively.~~ Additional requirements for individual systems and components are detailed in the following Parts.

■ *Section 2*
General provisions

2.1 Provisions

2.1.2 It is the responsibility of the Shipbuilder as main contractor to ensure that the ~~information~~ documentation required is prepared and submitted in accordance with a project schedule which has been agreed by LR.

2.1.5 ~~Provision shall be made to facilitate~~ Facilities are to be provided for cleaning, inspection and maintenance of main propulsion and auxiliary machinery including boilers and pressure vessels.

2.1.6 Where it is proposed to depart from the requirements of the Rules, an Engineering and Safety Justification, *see* Vol 1, Pt 1,2.2, ~~full details are~~ is to be submitted to Lloyd's Register (~~hereinafter referred to as '~~LR~~'~~) ~~to enable~~ for consideration ~~to be given to the circumstances of any special case~~.

2.1.7 Any novelty in the design and/or construction of machinery, boilers, pressure vessels or engineering equipment is to be advised to LR (*see also* Vol 2, Pt 1, Ch ~~5~~ 2).

■ *Section 3*
~~Particulars to be submitted~~
Documentation required for design review

3.1 Submission of information

3.1.1 ~~At least three copies of plans, information, and specifications~~ The documentation ~~as listed~~ described in Sections 3.2 to 3.5 ~~are~~ is to be submitted for design review before ~~commencement of manufacture~~ manufacturing has started.

3.2 ~~Plans~~ Documentation

3.2.2 ~~Individual Chapters list plans to be submitted for specific machinery and electrical systems or components. Also required are the~~ The following arrangement plans and ~~information~~ documentation are required, ~~where applicable:~~

(a) Plans showing the arrangement of machinery spaces indicating the location of machinery and equipment together with means of access and ventilation~~.~~;

(b) Plans showing the maintenance envelope and removal routes of machinery and equipment where routine removal for maintenance is proposed~~.~~;

~~(c) Where requested in individual Chapters, design statements which detail the system's capability and functionality under defined operating and emergency conditions. These design statements are to be agreed between the designer and Owner/Operator.~~

(c) System Operational Concept documents, where required by 3.4;

(d) System Design Descriptions, *see* 3.5; and

(e) Documentation as required by the individual Chapters for specific machinery and electrotechnical systems or components. This is to include their System Design Descriptions, *see* 3.5.

Where elements or sub-systems are to be integrated into a higher level system, an interface definition document shall be submitted detailing all the interfaces between them, electrical, mechanical, software or environmental. The level of detail provided shall enable the system integrator to assess their compatibility for correct operation as part of the higher level system.

3.2.4 Where operating requirements relating to the design, construction, testing, ~~and~~ installation, and integration of machinery and engineering systems have been defined within the scope of Section 4, evidence of capability and details of previous or proposed testing to demonstrate capability are to be submitted.

3.3 Calculations and specifications

~~*3.3.1* Relevant data covering paragraphs 3.3.2 to 3.3.9 as applicable is to be submitted.~~

Existing paragraphs 3.3.2 *to* 3.3.19 *have been renumbered* 3.3.1 *to* 3.3.18.

~~*3.3.4*~~ *3.3.3* **Short-term high power operation.** Where the propulsion machinery is being considered for short-term high power operation, full details of the power, speed and time intervals together with fatigue endurance calculations, and documentary evidence indicating the suitability of the component design under these conditions and for the intended class notation are required. The following are to be considered; prime mover, gearbox, flexible coupling, vibration dampers, shafting and propeller:

(a) The accrued number of load cycles and the percentage component overload are to be those recommended by the designers.

(b) Excessive overload may require the interval between surveys to be reduced.

(c) Plans showing the arrangement of resiliently mounted machinery which are to indicate the number, position, type and design of the mounts.

(d) Machinery is to be maintained in accordance with manufacturer's requirements.

(e) For electric propulsion:

  (i) The prime mover rated power in conjunction with its overloading and load build-up capabilities shall be adequate to supply the power needed during transitional changes in operating conditions of the electrical equipment due to manoeuvring and sea and weather conditions.

  (ii) Reverse power:
  When manoeuvring, for example from full propeller speed ahead to maximum design propeller speed astern with the ship making full way ahead, the prime-mover shall be capable of absorbing a proportion of the regenerated power without tripping due to overspeed or reverse power.

Means external to the mechanical and electrical rotating machinery may be provided in the form of, for example, braking resistors to absorb excess amounts of regenerated energy and to reduce the speed of the propulsion motor. The amount of regenerated power shall be limited by the control system. Generators operating with semiconductor converters shall be designed for the expected harmonics of the system. A sufficient reserve shall be considered for the temperature rise, compared with sinusoidal load.

(*Part only shown*)

~~3.3.6~~ *3.3.5* **Machinery Fastening:**

(a) For NS3 type ships or where specified ~~by the Naval Authority~~ for other ship types, documentary evidence and calculations indicating that machinery is securely mounted for the ship motions and accelerations to be expected during service.

(b) For NS3 type ships or where specified ~~by the Naval Authority~~ for other ship types, calculations to demonstrate that mountings of large masses such as main engines, auxiliary engines and electrical equipment can withstand the design collision acceleration according to 5.4.1 without fracturing.

~~3.3.7~~ *3.3.6* **Manuals**. The operation and maintenance manuals. For class notations covering propulsion and steering machinery redundancy ~~and dynamic positioning~~, *see* Volume 3.

~~3.3.8~~ *3.3.7* **A Risk Assessment (RA)**, in accordance with the guidance in Section 17, is to be carried out, covering the following systems:

(a) Main and auxiliary machinery systems supporting propulsion, steering or other essential services.

(b) Steering systems.

(c) Electrical generation and distribution systems supporting (a) and (b), *see* Pt 10, Ch 1, 5.2.4.

This requirement is in addition to the requirements for class notations covering propulsion and steering machinery redundancy ~~(see Volume 3)~~, and Ship Type piping systems (*see* Pt 7, Ch 5).

~~3.3.10~~ *3.3.9* **CBRN Protection arrangements.** Where the ~~Naval Authority has defined~~ CBRN Protection requirements are specified, a Design Statement together with plans and particulars ~~is~~ are to be submitted for information. *See* 4.12 for CBRN Protection guidance.

(*Part only shown*)

~~3.3.11~~ *3.3.10* **Machinery shock resistance arrangements**. Where ~~the Naval Authority has defined~~ shock capability requirements for machinery, engineering systems and equipment~~,~~ have been specified, the requirements of 4.11 apply and the following details are to be submitted:

~~3.3.12~~ *3.3.11* **Underwater signature arrangements**. Where the ~~Naval Authority has defined~~ underwater signature requirements for the ship and propulsion system have been specified, a design statement together with plans and particulars are to be submitted for information. *See* 4.10 for underwater signature guidance.

(*Part only shown*)

~~3.3.14~~ *3.3.13* **Fin stabilisers**. Where fin stabiliser systems are fitted ~~to a naval ship~~, the following details are to be submitted:

(a) A ~~design statement~~ System Design Description that details the stabiliser performance in terms of a specified roll angle that is not to be exceeded by more than a stated percentage of rolls in a specified wave environment (*see* Vol 1, Pt 5, Ch 2,2.3) at a specified ship speed and heading. ~~This statement is to be agreed between the designer and Owner/Operator~~ The performance is to be specified and is to recognise the requirements for ship-based operations, such as flight operations and replenishment at sea (RAS) systems, in terms of sea-keeping and platform heel/trim conditions, and the requirements of Section 4 regarding operating conditions as applicable. Details of any secondary function of the fin stabiliser to induce ship roll, for example routinely to test the fin stabiliser system (against its own induced roll), to facilitate weapon systems testing and to support CBRN Protection pre-wetting systems, are also to be included in the ~~design statement~~ System Design Description.

(b) Plans of all load bearing, torque transmitting components and hydraulic pressure retaining parts of the fin stabiliser system together with proposed rated torque, all relief valve settings and scantlings.

~~3.3.15~~ *3.3.14* **Machinery spaces and enclosures**. Evidence is to be submitted demonstrating the suitability of the fire-extinguishing arrangements for a machinery space or enclosure as required by 5.13.2. The submission is to identify all standards applied in support of the proposed arrangements. The location of equipment, the degree of protection provided by the equipment itself, and the damage control and fire-fighting ~~policy of the Navy or Naval Authority~~ requirements in the specified fire safety standard are to be taken into account in determination of the suitability of the fire-extinguishing arrangements.

(*Part only shown*)

~~3.3.18~~ 3.3.17 **Operation of machinery outside its recommended continuous operating design envelope.** Where equipment and machinery installed in mobility and ship type engineering systems may be required to operate for continuous periods outside its recommended continuous operating design envelope, details of the intended operating conditions, time intervals and frequency of use together with documentary evidence indicating the suitability of the design and any limitations under these conditions are required to be submitted. Arrangements may include time alongside~~,~~ manoeuvring, close-down and other military operations or trials. The following items of machinery and equipment are to be considered:

(h) Other items of machinery and equipment in mobility and ship type engineering systems as identified in the specified standards and agreed ~~between~~ by the Owner~~/Operator and Builder~~. The manufacturer's requirements and recommendations for operation and maintenance are to be addressed with provision as necessary of documentation such as manuals and warnings with particular reference to lubrication and cooling systems and any predicted adverse effects e.g., fouling. As far as practicable, the specification, selection and arrangements of machinery and equipment are to be agreed between the Shipbuilder and the Owner~~/Operator~~ for foreseeable operating conditions.

(*Part only shown*)

~~3.3.19~~ 3.3.18 **Training and drill regimes.** Where training and testing regimes for machinery capability and availability, reversionary modes of operation and breakdown drills have been identified by the Owner~~/Operator~~, full details of the intended regimes are required to be submitted in order to ascertain that the reliability of the machinery and associated systems is not significantly affected. The following are to be considered as applicable and included in the operating and maintenance manuals:

(f) Damage control and work-up exercises. As far as practicable, the specification, selection and arrangements of machinery and equipment are to be agreed between the Shipbuilder and Owner~~/Operator~~ for foreseeable training and drill regimes.

3.4 System operational concept

3.4.1 The purpose of this sub-Section is to ensure that LR is provided with all the necessary information at the whole ship system-level to perform design appraisal activities at sub-system and equipment level required by these Rules.

3.4.2 A System Operational Concept document is to be submitted, detailing the design intent and operational modes for complex systems which contain multiple sub-systems and significant items of equipment (e.g. Prime movers, propulsion devices, etc.). Examples of systems requiring the submission of a System Operational Concept include, but are not limited to:

- Propulsion (or Power and Propulsion for integrated systems).
- Electrical Power Generation and Distribution.
- Platform Management System.
- Replenishment at Sea (**RAS**) notation.
- Fire Protection (**FIRE**) notation.

3.4.3 The System Operational Concept is to include the following information, as appropriate to the system:

- Reference to the relevant requirements derived from the Concept of Operations;
- Operating modes and philosophy, including reversionary and emergency modes recognising the operational and manning philosophy for the vessel;
- Describe the designer's intent and the criticality of particular system features or equipment (with particular reference to those elements required to maintain essential services and those installed for capability only);
- Justify non-compliances with the Rules due to the system design and functionality (e.g. black start requirements applied to designated engines only);
- Information required to be included by the individual Chapters.

3.4.4 For ships without complex systems (e.g. single or dual engine installation), the System Operational Concept can be combined with the appropriate System Design Description, *see* 3.5.

3.4.5 The System Operational Concept documents are to be agreed between the designer and Owner. LR may accept alternative documents where these provide the information which would be included within the System Operational Concept. In such cases the relevant sections providing the information required to provide equivalence with the System Operational Concept are to be identified.

3.5 System design description

3.5.1 The requirements of this sub-Section aim to ensure that LR is provided with sufficient information at the sub-system and equipment level in order to undertake the design appraisal activities required by these Rules.

3.5.2 A System Design Description document is to be submitted to detail the system's sub-system or equipment capability and functionality under all normal and reasonably foreseeable abnormal operating and fault conditions. Examples of systems/equipment requiring the submission of a System Design Description include but are not limited to:

- Diesel Engines.
- Water jet systems.
- Piping systems.
- HVAC systems.
- Refrigeration Machinery (**PRM**) notation.

3.5.3 The System Design Description is to include the following information, as appropriate to the system:

- Where appropriate, reference to the related Concept of Operations and/or System Operational Concept document;
- Operating modes and philosophy including reversionary and emergency modes recognising the operational and manning philosophy for the vessel;
- System parameters (capacity, power, discharge rate, etc.);
- System redundancy;
- Degraded performance under extreme operating conditions;
- Information required for inclusion in the System Design Description by individual Chapters.

3.5.4 The System Operational Concept documents are to be agreed between the designer and Owner. LR may accept alternative documents where these provide the information which would be included within the System Operational Concept. In such cases the relevant sections providing the information required to provide equivalence with the System Operational Concept are to be identified.

■ *Section 4*
Operating conditions

4.1 Availability for operation

4.1.2 Installed machinery is to be capable of operating at defined power ratings with a range of fuels specified by the manufacturer and agreed by the Owner~~/Operator~~.

4.1.3 Smoke and emission levels from machinery exhaust systems are to be in accordance with those specified by the manufacturer and agreed by the Owner~~/Operator~~ over the full operating range.

4.1.5 Installed machinery is to be capable of operating satisfactorily in accordance with the manufacturer’s stated operating conditions within an operational envelope specified for the ship by the Owner~~/Operator~~ and agreed by the manufacturer/system designer, *see* 3.3.18. The optimum operational envelope is where machinery and equipment is operated to provide its best performance without causing undue wear or deterioration that could affect its operational reliability.

4.1.6 Installed machinery is to be capable of operating satisfactorily in accordance with the manufacturers stated operating conditions within defined training and drill regimes specified by the Owner~~/Operator~~ and agreed by the shipyard and machinery/equipment manufacturer, *see* 3.3.19.

Table ~~2.4.2~~ 3.4.2 Inclinations

NOTES
4. A static damaged condition up to a maximum of 30 degrees may be required by the ~~Naval Authority~~ specified standards.

4.5 Ambient operating conditions

4.5.2 Where it is intended to allow for operation in ambient temperatures outside those shown in Table 2.4.1, the permissible temperatures and associated periods of time are to be specified by the manufacturer and agreed by the Owner~~/Operator~~. Engineering systems should retain a continuous level of functional capability under these conditions and any level of degraded performance should be defined. Operation under these circumstances should not be the cause of damage to equipment in the system.

4.9 Military requirements

4.9.1 The ~~Naval Authority~~ Owner is responsible for defining the military requirements relating to the design, construction, testing and installation of machinery and engineering systems.

(*Part only shown*)
4.9.2 The following aspects are to be considered for machinery and engineering systems where military requirements are defined:
The foregoing list is not exhaustive and additional aspects may be specified and included by the ~~Naval Authority~~ Owner.

4.9.4 Where a military requirement for disabling automatic control, protection or safety functions for machinery and engineering systems has been defined ~~by the Naval Authority~~, the consequences of using the disabling arrangements are to be established and included in the operations procedures and orders provided on board the ship. Details of any disabling arrangements are to be recorded and submitted to LR for consideration in each instance.

4.10 Guidance for underwater signature

4.10.1 Where military requirements for underwater signature have been ~~identified by the Naval Authority~~ specified, the guidance in 4.10.2 to 4.10.4 may be used to assist in achieving the requirements. The ~~Naval Authority~~ Owner is responsible for defining the underwater signature and any requirements in addition to the guidance in this Section. The ~~design statement~~ System Design Description is to include underwater signature levels for the ship and propulsion system, which should be agreed between the designer and Owner, *see* 3.3.12.

4.10.2 Acceptance levels for propulsion and underwater signature are normally ~~to be defined~~ specified by the ~~Naval Authority~~ Owner such that propulsive performance and the underwater signature may be determined.

4.11 Machinery shock arrangements

4.11.1 Where shock requirements for machinery, engineering systems and equipment have been ~~identified by the Naval Authority~~ specified, the requirements of this Section are to be met. The ~~Naval Authority~~ Naval Administration is responsible for determining and specifying if these Rules are adequate to meet their requirements and defining any alternative or additional requirements ~~in addition to the Rules in this Section~~. These Rules may be applied in isolation from or in addition to the requirements of the Shock Enhancement notation, SH, *see* Vol 1, Pt 4, Ch 2,5.

(*Part only shown*)
4.11.2 A shock ~~policy,~~ System Design Description ~~agreed between the designer,~~ may be specified by the Owner~~/Operator and the Naval Authority is to be defined for the ship~~. The ~~policy~~ System Design Description is to identify the level of shock resistance for installed machinery, engineering systems and equipment and is to address:
The application of design and installation of machinery systems for shock resistance is dependent on the Owner~~/ Operator~~ requirements detailed in the shock policy.

Shock capability may range from full operational capability after repeated shock to that for retaining items captive to avoid injury to personnel.

4.11.5 The shock performance of individual items of ship's equipment required to operate after shock loading is to be assessed by conducting representative shock tests. For larger items of equipment, a combination of shock tests and numerical modelling may be used, ~~subject to the agreement of the Naval Authority~~ as defined in the System Design Description.

4.11.6 Where equipment shock testing is required, it is to be carried out at a recognised facility in accordance with an acceptable procedure ~~acceptable to the Naval Authority~~. It is to be ensured that the test arrangements represent the magnitude and direction of loads, and that the loading is applied to the equipment in the configuration in which it will be fitted on board, including shock mounts if applicable.

4.11.10 For systems, machinery and equipment which are required to be shock captive or shock capable, non-ductile, brittle, low impact resistance, or high notch sensitivity materials, particularly grey cast iron and cast aluminium are not to be used unless their use can be justified and agreed with the ~~Naval Authority~~ Naval Administration. Materials used, where possible, are to be capable of yielding by approximately 10 per cent before fracture. Whenever possible, the use of glass is to be avoided in machinery, engineering systems and equipment. Where this is not possible, toughened glass is to be used. Where glass is used in tank level gauges, for tanks containing flammable fluids, automatic self-closing valves are to be fitted at the top and bottom of the gauge to prevent the loss of fluid.

4.11.19 Where required by the ~~Naval Authority~~ shock System Design Description, piping containing flammable fluids passing through compartments of high fire risk are to meet the requirements of 4.11.16 to 4.11.18.

4.11.20 Where equipment is required to remain captive, securing arrangements are to be designed to resist the acceleration/deceleration levels which are associated with the location of the equipment within the ship. The shock captivity levels are to be identified in the ~~design statement~~ System Design Description.

4.12 Guidance for CBRN protection, detection and monitoring

4.12.1 Where military requirements to operate under the threat of Chemical, Biological, Radiological and Nuclear (CBRN) warfare have been ~~identified by the Naval Authority~~ specified, the guidance in 4.12.2 to 4.12.14 may be used to assist in achieving the requirements. The ~~Naval Authority~~ Owner is responsible for defining the levels of threat, operating periods and for specifying any CBRN Protection requirements in addition to the guidance in this Section. The ~~design statement~~ System Design Description for CBRN Protection of the ship should be agreed between the designer and Owner~~/Operator~~, *see* 3.3.10. For hull structure guidance, *see* Vol 1, Pt 4, Ch 1,7.

4.12.3 The ship will have a citadel in which the crew can shelter and in particular, ship operations can be managed for long-term close-down conditions. This citadel may be part or all of the ship. Larger citadels may be sub-divided into a number of smaller sub-citadels. The duration of operation with a citadel in use is to be defined in the ~~design statement~~ System Design Description.

4.12.5 Fresh air required for ventilation purposes should pass through an appropriate level of filtration before entering the citadel. Jalousies fitted at the intakes should be capable of controlling the ingestion of water, particulate and corrosive marine salts to limit degradation of filter units due to moisture carry over. The air filtration units should be capable of providing protection against nuclear, biological and chemical threats defined ~~by~~ in the ~~Naval Authority~~ specified standards and should be capable of being cleaned and maintained in accordance with the manufacturer's recommendations. The air filtration systems should be capable of being operated from within the citadel. The maintenance arrangements for air filtration systems should ensure that there is minimum risk of introduction of contaminants into the citadel.

4.13 Electromagnetic compatibility (EMC)

4.13.2 An EMC test plan is to be established, an EMC analysis carried out and a test report produced in accordance with the requirements and guidelines of IEC 60533 *Electrical Installations in Ships, Electromagnetic Compatibility* or equivalent requirements of the ~~Naval Authority~~ Naval Administration as defined in ~~an appropriate naval~~ a specified standard. Regard is to be given to the fact that EMC requirements for systems installed on board naval ships may be more onerous due to the high concentration of electronic equipment, transmitters and receivers located in close proximity. Details are to be submitted for appraisal.

4.13.3 Systems are to comply with the emission limits and minimum immunity requirements of the ~~Naval Authority as defined in an appropriate naval~~ specified standards. This may require systems complying with emissions and immunity requirements of IEC 60533 *Electrical Installations in Ships, Electromagnetic Compatibility* to be subjected to additional testing in order to demonstrate the requirements of the ~~Naval Authority~~ specified standards are satisfied, unless the EMC analysis clearly identifies such testing to be unnecessary. Details are to be submitted for appraisal.

■ *Section 5*
Machinery space arrangements

5.3 Machinery fastenings

5.3.1 Bedplates, thrust seatings and other fastenings are to be of robust construction, and the machinery is to be securely fixed to the ship's structure to the satisfaction of the Surveyor. For NS3 type ships or where specified ~~by the Naval Authority~~, the arrangement is to be such that is sufficient to restrain the dynamic forces arising from vertical and horizontal acceleration appropriate to the intended service, see 3.3.6 and 5.4.

5.6 Resin chocks

5.6.4 Where the ~~Naval Authority~~ ship has ~~defined~~ specified military requirements that include design and installation of machinery to withstand shock, the resin is to be approved for this application.

5.9 Means of escape

(*Part only shown*)

5.9.1 Except as permitted in 5.9.2, two means of escape are to be provided from each machinery space of Category A. In particular, one of the following provisions are to be complied with:

Alternative arrangements in accordance with the requirements as specified by ~~of~~ the ~~Naval Authority~~ Naval Administration may also be acceptable.

5.9.2 Where specified and agreed by the ~~Naval Authority~~ Naval Administration, in an NS3 category ship, one of the means of escape required in 5.9.1 may not be required with due regard being paid to the dimension and disposition of the upper part of the space.

■ *Section 18*
Fin stabilisers

18.1 Design and construction

~~*18.1.5* Attention is to be given to any relevant requirements of the Naval Authority.~~

18.2 Performance and control

18.2.1 Fin stabilisers are to be capable of satisfying the specified functional performance requirements as detailed in the ~~design statement~~ System Design Description, *see* 3.3.14(a).

18.4 Trials and testing

18.4.2 Testing and trials are to be carried out in accordance with procedures that have been agreed between the Shipyard, Owner~~/Operator~~ and LR. The testing is to demonstrate:

(a) The stabiliser system including the functional performances specified in the ~~design statement~~ System Design Description required by 3.3.14(a).

■ *Section 19*
Fired galley arrangements

19.1 Oil and liquefied petroleum gas fired galleys

19.1.1 The use of oil or liquefied petroleum gas fired galleys is acceptable provided arrangements are also acceptable to the ~~Naval Authority~~ Naval Administration and the requirements of 19.1.2 to 19.1.6 are complied with.

19.1.5 When liquefied petroleum gas is used, bottles are to be stored on the open deck or in a well ventilated space which only opens to the open deck. Protection against military action is to be ~~to the satisfaction of the Naval Authority~~ provided.

Volume 2, Part 1, Chapter ~~3~~ 4

Requirements for Fusion Welding of Pressure Vessels and Piping

Effective Date 1 January 2015

Chapter 3 has been renumbered Chapter 4 and all references have been amended.

Volume 2, Part 1, Chapter ~~4~~5

Spare Gear Machinery for Installations

Effective Date 1 January 2015

Chapter 4 and been renumbered Chapter 5 and all references have been amended.

■ *Section 1*
Scope

1.1 Application

1.1.2 The spare parts to be supplied and their location is to be the responsibility of the ~~Navy~~ Owner but must take into account the design and arrangements of the machinery and the intended service and operation of the ship. Account should also be taken of the recommendations of the manufacturers ~~and any applicable requirement of the Naval Authority~~.

Volume 2, Part 1, Chapter ~~5~~ 2

Requirements for Machinery and Engineering Systems of Unconventional Design

Effective Date 1 January 2015

Chapter 5 has been renumbered Chapter 2 and all references have been amended.

■ *Section 1*

Requirements for machinery and engineering systems of unconventional design

1.2 ~~Information to be submitted~~ Documents required for design review

1.2.3 ~~General description~~ A System Design Description detailing the extent of the machinery or engineering system~~,~~ is to be provided. This is to describe the shipboard services ~~it~~ the system is to provide, its operating principles, and its functionality and capability when operating in the environment to which it is likely to be exposed under both normal and foreseeable abnormal conditions. *See* Ch 2,3.5. The ~~general description~~ System Design Description is to be supported by the following information as applicable:

(a) System block diagram.

(b) Piping and instrumentation diagrams.

(c) Description of operating modes, including:
Start-up, ~~shut down~~ shutdown, automatic, reversionary, manual and emergency.

(d) Description of safety related arrangements, including:
Safeguards, automatic safety systems and interfaces with ships' safety systems.

(e) Description of connections to other shipboard machinery, equipment and systems, including: Electrical, mechanical, fluids and automation.

(f) Plans of physical arrangements, including:
Location, operational access and maintenance access.

(g) System Operational Concept document, where appropriate, *see* Ch 2,3.4.

~~(g)~~(h) Operating manuals, including:
Instructions for start-up, operation, ~~shut down~~ shutdown, instructions for maintenance, instructions for adjustments to the performance and functionality and details of risk mitigation arrangements.

~~(h)~~(j) Maintenance manuals, including:
Instructions for routine maintenance, repair following failure, disposal of components and recommended spares inventory.

1.4 Requirements definition

(*Part only shown*)

1.4.2 The procedure is to take account of requirements resulting from key stakeholders, including:

(a) Ship's owner.

(b) Ship's operator.

(k) ~~Naval Authority~~ Naval Administration.

Volume 2, Part 2, Chapter 1

Diesel Engines

Effective Date 1 January 2015

■ *Section 1*

General requirements

1.1 Application

1.1.1 This Chapter is to be read in conjunction with the requirements for Machinery and Engineering Systems in Pt 1, Ch 1 and Ch ~~2~~ 3.

■ *Section 2*

~~Particulars to be submitted~~ Documents required for design review

2.1 ~~Plans and information~~ Documentation

2.1.2 The following information and calculations are to be submitted:

- Crankshaft design data as outlined in Section 4.
- Combustion pressure-displacement relationship.
- Power/speed operational envelope.
- Calculations and information for short-term high power operation where applicable.
- Arrangement and welding specifications with details of the procedures for fabricated bedplate, thrust bearing bedplate, crankcases, frames and entablatures. Details of materials, welding consumables, fit-up conditions, fabrication sequence and heat treatments are to be included.
- Operation and maintenance manuals.
- Material specifications covering the listed components together with details of any surface treatments, non-destructive testing and hydraulic tests.
- Arrangement of interior lighting, where provided.
- Engine Type test programme, where required including proposals for short term high power operation.
- Alternative proposals for hydraulic tests where design features are such that modifications to the test requirements are necessary.
- Thrust bearing assembly (if integral with engine and not integrated in the bedplate).
- Counterweights, where attached to crank-throw, including fastening.
- Main engine holding down arrangement.
- System Operational Concept covering the Propulsion system, *see* Pt 1, Ch 2,3.4.
- ~~Design statement~~ System Design Description for engine systems, *see* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5 and 15.2.

2.1.5 Plans and details for dead ship condition starting arrangements are to be submitted for appraisal, *see* ~~7.11~~ Pt 7, Ch 3,12.11.

■ *Section 6*

Safety arrangements on engines

6.2 Crankcase relief valves

6.2.4 ~~In engines having cylinders not exceeding 200 mm bore or having a crankcase gross volume not exceeding 0,6 m^3, relief valves may be omitted.~~ Internal combustion engines having a cylinder bore of 200 mm and above or a crankcase volume of 0,6 m^3 and above shall be provided with crankcase explosion relief valves.

■ *Section 7*

~~Air compressors and starting~~ Starting arrangements

7.1 ~~General requirements~~ Air starting

7.1.1 ~~The requirements of this Section are applicable to reciprocating air compressors intended for starting main engines and auxiliary engines providing essential services.~~ Air starting arrangements are to meet the requirements of Pt 7, Ch 3,12.

Existing paragraphs 7.1.2 *to* 7.1.6 *have been renumbered* Pt 7, Ch 3*,* 12.1.2 *to* 12.1.6.

Existing sub-Section 7.2 *has been renumbered* Pt 7, Ch 3*,* 12.2.

Existing paragraphs 7.2.1 *to* 7.2.2 *have been renumbered* Pt 7, Ch 3*,*12.2.1 *to* 12.2.2.

Existing sub-Section 7.3 *has been renumbered* Pt 7, Ch 3*,* 12.3.

Existing paragraphs 7.3.1 *to* 7.3.4 *have been renumbered* Pt 7, Ch 3, 12.3.1 *to* 12.3.4.

Existing sub-Section 7.4 *has been renumbered* Pt 7, Ch 3*,* Pt 7, Ch 3, 12.4.

Existing paragraphs 7.4.1 *to* 7.4.12 *have been renumbered* Pt 7, Ch 3*,* 12.4.1 *to* 12.4.12.

Existing sub-Section 7.5 *has been renumbered* Pt 7, Ch 3*,* 12.5.

Existing paragraphs 7.5.1 *to* 7.5.2 *have been renumbered* Pt 7, Ch 3*,* 12.5.1 *to* 12.5.2.

Existing sub-Section 7.6 *has been renumbered* Pt 7, Ch 3*,* 12.6.

Existing paragraphs 7.6.1 *to* 7.6.4 *have been renumbered* Pt 7, Ch 3*,* 12.6.1 *to* 12.6.4.

Existing sub-Section 7.7 *has been renumbered* Pt 7, Ch 3, 12.7.

Existing paragraphs 7.7.1 *to* 7.7.8 *have been renumbered* Pt 7, Ch 3, 12.7.1 *to* 12.7.8.

Existing sub-Section 7.8 *has been renumbered* Pt 7, Ch 3, 12.8.

Existing paragraphs 7.8.1 *to* 7.8.4 *have been renumbered* Pt 7, Ch 3, 12.8.1 *to* 12.8.4.

Existing sub-Section 7.9 *has been renumbered* Pt 7, Ch 3, 12.9.

Existing paragraphs 7.9.1 *to* 7.9.4 *have been renumbered* Pt 7, Ch 3, 12.9.1 *to* 12.9.4.

Existing sub-Section 7.10 *has been renumbered* Pt 7, Ch 3, 12.10.

Existing paragraph 7.10.1 *has been renumbered* Pt 7, Ch 3, 12.10.1.

Existing sub-Section 7.11 *has been renumbered* Pt 7, Ch 3, 12.11.

Existing paragraphs 7.11.1 *to* 7.11.5 *have been renumbered* Pt 7, Ch 3, 12.11.1 *to* 12.11.5.

Existing sub-Section 7.12 *has been renumbered* Pt 7, Ch 3, 12.12.

Existing paragraphs 7.12.1 *to* 7.12.5 *have been renumbered* Pt 7, Ch 3, 12.12.1 *to* 12.12.5.

Existing sub-Section 7.13 *has been renumbered* Pt 7, Ch 3,12.13.

Existing paragraphs 7.13.1 *to* 7.13.8 *have been renumbered* Pt 7, Ch 3, 12.13.1 *to* 12.13.8.

~~7.14~~ 7.2 Electrical starting arrangements

~~7.14.1~~ 7.2.1 Where main engines are fitted with electric starters, two batteries are to be fitted. Each battery is to be capable of starting the engines when cold and the combined capacity is to be sufficient without recharging to provide the number of starts of the main engines as required by ~~7.12~~ Pt7, Ch3, 12.

Existing paragraphs 7.14.2 and 7.14.3 have been renumbered 7.2.2 and 7.2.3.

~~7.14.4~~ 7.2.4 Engine starting batteries are to be used only for the purposes of starting the engines and for the engines' own control, alarm, monitoring and safety arrangements. Means are to be provided to ensure that the stored energy in the batteries is maintained at a level required to start the engines as defined in ~~7.14.1~~ 7.2.1 and ~~7.14.3~~ 7.2.3.

Existing paragraphs 7.14.5 *to* 7.14.7 *have been renumbered* 7.2.5 *to* 7.2.7.

~~7.15~~ 7.3 Starting of the emergency source of power

Existing paragraphs 7.15.1 *to* 7.15.5 *have been renumbered* 7.3.1 *to* 7.3.5.

~~7.15.6~~ 7.3.6 When hand (manual) starting is not practicable, the provisions of ~~7.15.2~~ 7.3.2 and ~~7.15.3~~ 7.3.3 are to be complied with except that starting may be manually initiated.

~~7.15.7~~ 7.3.7 Electric starting arrangements are also to satisfy ~~7.14.2 to 7.14.5~~ 7.2.

~~7.16~~ 7.4 Engine control, alarm, monitoring and safety system power supplies

Existing paragraphs 7.16.1 *to* 7.16.3 *have been renumbered* 7.4.1 *to* 7.4.3.

■ *Section 8*
Piping systems

8.8 Air induction systems

8.8.2 Where there is a ~~navy~~ requirement to provide a ducted air system to convey air from inlets on deck to the engine, the requirements of 8.8.3 to 8.8.6 are to be complied with.

■ *Section 9*
Control and monitoring

9.7 Diesel engines for propulsion purposes

9.7.7 The number of automatic consecutive attempts which fail to produce a start are to be limited to three attempts. For reversible engines which are started and stopped for manoeuvring purposes, means are to be provided to maintain sufficient starting air in the air receivers. For electric starting, *see* ~~7.14~~ 7.2.

9.8 Auxiliary and other engines

(*Part only shown*)

Table 1.9.2 Auxiliary diesel engines: Alarms and shut-downs

NOTES
1. ~~The arrangements are to comply with the requirements of the Naval Authority concerned.~~ The tailoring document or System Design Description may specify additional requirements of the Naval Administration.
2. Alarm only required when an exhaust gas economiser/boiler/thermal oil heater is fitted.
3. Alternatively, details (including location) of an appropriate fire detection system are to be submitted for consideration.

■ *Section 15*
Electronically controlled engines

15.2 ~~Plans and particulars~~ Documentation required for design review

(*Part only shown*)

15.2.1 In addition to the plans and particulars required by Ch 1,2 the following information is to be submitted:

(a) ~~A~~ The System Design Description required by 2.1.2 is to include a general overview of the operating principles supported by schematics explaining the functionality of individual systems and sub-systems. The information is to relate to the engine capability and functionality under defined operating and emergency conditions such as recovery from a failure, degraded modes of operation, or malfunction, with particular reference to the functioning of programmable electronic systems and any sub-systems. Also, the information is to indicate if the engine has different modes of operation, such as to limit exhaust gas emissions and/or to run under an economic fuel consumption mode or any other mode that is electronically controlled.

15.7 Emergency engines

15.7.2 ~~Evidence is to be submitted confirming that the Naval Authority accepts the proposed use of an electronically controlled engine for emergency power purposes.~~ The use of electronically controlled engines for emergency power purposes will only be permitted if specified by the Naval Administration.

Volume 2, Part 2, Chapter 2

Gas Turbines

Effective Date 1 January 2015

■ *Section 1*
General requirements

1.1 ~~Chapter-specific definitions~~ Definitions

~~*1.1.1* Where any of the terms contained within this Section are used within this Chapter, their meaning is to be as defined in 1.1.2–1.1.9.~~

Existing paragraphs 1.1.2 *to* 1.1.6 *have been renumbered* 1.1.1 *to* 1.1.5.

~~*1.1.7* Concept of Operations. The Concept of Operations (ConOps) is a statement of an Owner's/Operator's intentions for the operation of the ship. The ConOps describes the ship's intended service in terms of purpose and function and is to include, but is not to be limited to, information on the following: crewing, operational speeds, wave heights, displacements, service area, temperatures, motions, aircraft and boat operations, and arrangements under reasonably foreseeable, normal and abnormal conditions. The ConOps is to be provided by the Owner/Operator.~~

~~*1.1.8* System Operational Concept. A System Operational Concept is a description of the intended operation of a major ship system that is comprised of sub-systems and equipment referenced within the Rules. The System Operational Concept is to demonstrate that the system's architecture, configuration and criticality meet the requirements of the operational scenarios defined by the ConOps. The System Operational Concept statements are to be agreed between the designer and Owner/Operator.~~

~~*1.1.9* System Design Description. The System Design Description is a document that describes the design of a system or equipment. The System Design Description details the system's capability and functionality under all normal and reasonably foreseeable abnormal operating and fault conditions. The System Design Description documents are to be agreed between the designer and Owner/Operator.~~

■ *Section 5*
~~Particulars to be submitted~~ Documentation required for design review

5.2 ~~Plans and information~~ Documentation

■ *Section 9*
Starting arrangements

9.3 Air starting

9.3.1 ~~Where the gas turbine is arranged for air starting, the air start system is to comply with the requirements set out in Pt 2, Ch 1,7.13. The total air receiver capacity is to be sufficient to provide, without replenishment, no fewer than six consecutive starts. At least two air receivers of approximately equal capacity are to be provided to satisfy the plant air start requirements. For requirements regarding air receivers, see Pt 8, Ch 2.~~ Air starting arrangements are to meet the requirements of Pt7, Ch3, 12. Exhaust from the start air system is to be arranged so as not to present a hazard to the crew.

~~*9.3.2* For installations of more than one gas turbine, three consecutive starts per gas turbine are required.~~

~~*9.3.3* Each air receiver is to be fitted with a drain arrangement at its lowest part, permitting oil and water to be blown out.~~

~~*9.3.4* Each receiver which can be isolated from a relief valve is to be provided with a suitable fusible plug to discharge the contents in case of fire. The melting point of the fusible plug is to be approximately 150°C.~~

~~*9.3.5* Receivers used for the storage of air for the control of remotely operated valves are to be fitted with relief valves, not fusible plugs.~~

~~*9.3.6* Exhaust from the air start system is to be arranged so as not to present a hazard to the crew.~~

~~9.4 Starting air pipe systems and safety fittings~~

~~*9.4.1* Air start piping systems are, in general, to comply with the requirements of Part 7, with due regard being paid to the particular type of installation.~~

~~*9.4.2* When designing the compressed air installation, care is to be taken that the compressor air inlets will be located in an atmosphere reasonably free from oil vapour or, alternatively, an air duct from outside the machinery space is to be led to the compressors.~~

~~*9.4.3* The air discharge pipe from the compressors is to be led directly to the starting air receivers. Provision is to be made for intercepting and draining oil and water in the air discharge for which purpose a separator or filter is to be fitted in the discharge pipe between compressors and receivers.~~

~~*9.4.4* The starting air pipe system from receivers to main and auxiliary engines is to be entirely separate from the compressor discharge pipe system. Stop valves on the receivers are to permit slow opening to avoid sudden pressure rises in the piping system. Valve chests and fittings in the piping system are to be of ductile material.~~

~~*9.4.5* Drain valves for removing accumulations of oil and water are to be fitted on compressors, separators, filters and receivers. In the case of any low-level pipelines, drain valves are to be fitted to suitably located drain pots or separators.~~

~~*9.4.6* The starting air piping system is to be protected against the effects of explosions by the provision of an isolating non-return valve or equivalent at the starting air supply to each unit.~~

~~*9.4.7* Alternative arrangements are subject to special consideration.~~

~~9.5~~ 9.4 Electric starting

Existing paragraph 9.5.1 *has been renumbered* 9.4.1.

~~9.6~~ 9.5 Hydraulic starting

Existing paragraph 9.6.1 *has been renumbered* 9.5.1.

Volume 2, Part 2, Chapter 3
Steam Turbines

Effective Date 1 January 2015

■ *Section 2*
~~Particulars to be submitted~~ Documentation required for design review

2.1 ~~Plans and information~~ Documentation

2.1.1 The following plans are to be submitted for consideration~~, together with particulars of materials, maximum shaft powers and revolutions per minute. The pressures and temperatures applicable at maximum shaft power and under the emergency conditions of 5.2 are to be stated or indicated on the plans~~:

- General arrangement.
- Sectional assembly.
- Rotors and couplings.
- Casings.

2.1.2 ~~For the emergency conditions of 5.3, full particulars of the means proposed for emergency propulsion are to be submitted.~~ A System Operational Concept covering the Propulsion system is to be submitted, *see* Pt 1, Ch 2,3.4.

2.1.3 ~~Where rotors and castings are of welded construction, details of the welded joints are also to be submitted for consideration.~~ A System Design Description is to be submitted (*see* Pt 1, Ch 2,3.5) containing the following information:

- Particulars of materials;
- Maximum shaft powers;
- Maximum and minimum revolutions per minute;
- The pressures and temperatures applicable at maximum shaft power and under the emergency conditions of 5.2 are to be stated (or indicated on the plans);
- For the emergency conditions of 5.3, full particulars of the means proposed for emergency propulsion.

■ *Section 7*
Control and monitoring

7.5 Steam turbines for propulsion purposes

Table 3.7.2 Steam turbine machinery: Additional alarms and safeguards

Item	Alarm	Note
Lubricating oil inlet temperature	High	—
Lubricating oil inlet pressure	1st stage Low	—
	2nd stage* Low	Automatic shut-down of turbine*, *see* 7.5.2
Condenser vacuum	Low	Automatic shut-down of turbine*
Axial displacement of rotor	High	
Overspeed	High	*See* 7.2

NOTE
There are no classification requirements for the items marked * in the case of engines being used for the emergency source of electrical power.
~~The arrangements are to comply with the requirements of the Naval Authority concerned.~~ The tailoring document or System Design Description may specify additional requirements of the Naval Administration.

Volume 2, Part 3, Chapter 1
Gearing

Effective Date 1 January 2015

■ *Section 2*
Principles

2.3 Enhanced analysis principles

2.3.1 Where the design of gearing has used enhanced analysis methods as described in 2.3.2 to 2.3.5, the ship will be eligible for the optional machinery class notation **AG1** or **AG2** as applicable. These optional class notations may be applied where the Owner~~/operator~~ requires detailed knowledge of the reliability of the gear elements and where noise excitation is required to be minimised for anticipated service conditions. Eligibility for the **AG1** class notation will be subject to analysis in accordance with ISO 6336 and the use of an acceptable validated analytical meshing model for determining the face load factor for contact stress $K_{H\beta}$ by direct calculations.
The analytical mesh model is to include consideration of the following:

(a) Phase varying lines of contact at the mesh.
(b) Elastic deflection of the gears, supporting shafts and other supporting components.
(c) Geometric qualities of any helix and profile modifications.
(d) Manufacturing tolerances.

■ *Section 3*
Acceptance criteria

3.1 General

3.1.1 Conformance with the performance criteria, together with any specific requirements of the applicable Rules, standards and legislation is to be demonstrated by the gear manufacturer, shipbuilder and ~~navy/operator~~ Owner to the satisfaction of Lloyd's Register (hereinafter referred to as 'LR').

3.1.2 For gears, the applicable Rules and Standards for classification are:

(a) LR Rules for the Classification of Naval Ships.
(b) ISO 6336 Parts 1, 2, 3 and 5.
(c) ISO 1328 – *Parallel involute gears ISO System of Accuracy*.
(d) ISO 1940 – *Balancing*.
(e) Requirements of the ~~Naval Authority~~ Naval Administration as specified, *see* 3.1.3.
(f) Other specific Owner requirements. These are to be identified before commencement of design review or construction.
(g) LR Type Approval System.
(h) LR Quality Scheme for Machinery.

~~*3.1.3* Where LR is acting on behalf of the Naval Authority, any relevant requirements of the Naval Authority are to be identified and advised to LR.~~

■ *Section 5*
~~Plans and particulars to be submitted~~ Documentation required for design review

5.3 Design data and calculations

5.3.1 A d~~esign statement~~ System Design Description for the gearing installation, *see* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5.

Volume 2, Part 3, Chapter 2

Shafting Systems

Effective Date 1 January 2015

■ *Section 2*
~~Particulars to be submitted~~ Documentation required for design

2.1 ~~Plans~~ Documentation

Volume 2, Part 4, Chapter 1

Propellers

Effective Date 1 January 2015

Section 2
Principles

2.3 Enhanced assessment of manufacturing tolerance principles

2.3.1 Where the design of a propeller has used enhanced assessment methods for manufacturing tolerances as described in 8.4 and 8.5, the ship will be eligible for the optional machinery class notation **AP1** or **AP2** as applicable. These optional class notations may be applied where the Owner~~/Operator~~ requires detailed knowledge of a propeller's manufacturing tolerances and where noise or the effects of cavitation are required to be minimised for anticipated service conditions.

Section 3
Acceptance criteria

3.1 General

3.1.2 For propellers, the applicable Rules and Standards for classification are:

(a) LR *Rules for the Classification of Naval Ships*.
(b) ISO 484/1 Shipbuilding – Ship Screw Propellers – Manufacturing Tolerances, Part 1: *Propellers of Diameter greater than 2,5 m*.
(c) ISO 484/2 Shipbuilding – Ship Screw Propellers – Manufacturing Tolerances, Part 2: *Propellers of Diameter between 0,8 and 2,5 m inclusive*.
(d) Requirements of the ~~Naval Authority~~ Naval Administration as specified, *see* 3.1.3.
(e) Other specific Owner requirements. These are to be identified before commencement of design review or construction.
(f) LR Quality Scheme for Machinery.

Where it is proposed to use manufacturing tolerances other than those stated in the ISO Standards, these are to be agreed between the manufacturer and the Owner and advised to LR.

~~*3.1.3* Where LR is acting on behalf of the Naval Authority, any relevant requirements of the Naval Authority are to be identified and advised to LR.~~

Section 5
~~Plans and Particulars~~ Documentation required for design review

5.1 ~~Particulars to be Submitted~~ Documentation

Volume 2, Part 4, Chapter 2

Water Jet Systems

Effective Date 1 January 2015

■ *Section 2*

General requirements

2.2 ~~Plans to be submitted~~ Documentation required for design review

Volume 2, Part 4, Chapter 3

Thrusters

Effective Date 1 January 2015

■ *Section 2*
~~Particulars to be submitted~~ Documentation required for design review

2.3 Calculations and specifications

2.3.1 **Fixed/Azimuth propulsion thrusters:** A System Design Description (*see* Pt 1, Ch 2,3.5) containing the following:

(a) Thruster prime mover type and operational power/speed envelope.

(b) Rating and type of motor for the azimuthing mechanism (e.g., type – hydraulic or electric).

(c) Gearing calculations for the azimuthing mechanism which is to be designed to a recognised National or International Standard.

(d) Bearing specifications.

(e) Details of control engineering aspects in accordance with Pt 9, Ch 1.

(f) Calculations indicating suitability of components for short-term high power operation, where applicable. *See* Pt 1, Ch 2.

(g) Where carried out in accordance with Pt 1, Ch 2, a fatigue strength analysis of components indicating a factor of safety of 1,5 at the design loads, based on a suitable fatigue failure criteria.

2.3.2 **Tunnel thrusters.** ~~Specification for materials of~~ A System Design Description (*see* Pt 1, Ch 2,3.5) detailing the gears, shafts, couplings and propeller, stock and struts, the thruster prime mover type and the operational power/speed envelope.

Volume 2, Part 4, Chapter 4

Podded Propulsion Units

Effective Date 1 January 2015

■ *Section 1* Scope

1.1 Application

1.1.1 This Chapter applies to podded propulsion units where used for propulsion~~, dynamic positioning duty~~ or as the sole means of steering.

~~*1.1.6* Attention is to be given to any relevant requirements of the Naval Authority.~~

Existing paragraphs 1.1.7 *to* 1.1.8 *have been renumbered* 1.1.6 *to* 1.1.7.

■ *Section 2* General requirements

2.2 ~~Plans and information to be submitted~~ Documentation required for design review

(*Part only shown*)

2.2.1 In addition to the plans required by Pt 3, Ch 1 and Ch 2, Pt 4, Ch 1, Pt 5, Pt 6, Ch 1, Pt 7, Ch 3 and Parts 9 and 10, the following plans and information are required to be submitted for appraisal. Where appropriate, the information shall be contained in a System Design Description document, *see* Pt 1, Ch 2,3.5:

(g) Details of the intended manoeuvring capability of the ship in each operating condition.~~(to be declared by the naval authority, *see also* 3.1.1).~~

■ *Section 3* Functional capability

3.1 General

~~*3.1.3* The steering mechanism for podded units used for Dynamic Positioning applications with an associated class notation, is to be capable of a rotational speed of not less than 1,5 rev/min.~~

Existing paragraph 3.1.4 *has been renumbered* 3.1.3.

Volume 2, Part 4, Chapter 5

Electric Propulsion

Effective Date 1 January 2015

Scope

The requirements of this Chapter are applicable to the design and construction philosophy of electrical propulsion systems that utilise converter fed propulsion motors.

This Chapter details the requirements for electric propulsion system as a standalone system as well as integrated electrical power generation and propulsion systems.

Section 1
Functional requirements

1.1 Functional requirements

1.1.1 Electric propulsion machinery shall enable the ship to manoeuvre as and when required, and remain within the designed or imposed limitations in both ahead and astern modes of operation.

Section 2
Performance requirements

2.1 Performance requirements

2.1.1 The propulsion equipment and systems shall be designed, constructed and maintained to minimise danger to personnel on board in all foreseeable operating conditions.

2.1.2 The design, construction, installation and operation of propulsion equipment shall not cause interference or excessive forces that could lead to its failure or failure of other equipment and systems.

2.1.3 Effective means of communicating orders from the conning positions to any position from which the speed and direction of thrust of the propellers can be controlled shall be provided.

2.1.4 Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative.

Section 3
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Section 4 is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

Section ~~16~~ 4
Electric propulsion systems

The amends shown in Section 4 have been moved from Pt 10 Ch 1, Sections 9 and 16.

~~16.1~~ 4.1 General

4.1.1 This Chapter is to be read in accordance with the appropriate Chapters of Vol 2, Parts 9 and 10.

Existing paragraphs Pt 10, Ch1, 16.1.1 *and* 16.1.2 *have been renumbered* Pt 4, Ch 5, 4.1.2 *and* 4.1.3.

~~16.1.3~~ 4.1.4 The embedded temperature detectors required by ~~9.1.10~~ 4.7.3 are to be arranged to operate an alarm if the temperature exceeds a predetermined safe value.

Existing paragraph Pt 10, Ch1, 16.1.4 *has been renumbered* Pt 4, Ch 5, 4.1.5.

~~16.2~~ 4.2 System design and arrangement

Existing paragraphs Pt 10, Ch1, 16.2.1 *and* 16.2.2 *have been renumbered* Pt 4, Ch 5, 4.2.1 *and* 4.2.2.

~~16.3~~ 4.3 Power requirements

Existing paragraphs Pt 10, Ch1, 16.3.1 *to* 16.3.9 *have been renumbered* Pt 4, Ch 5, 4.3.1 *to* 4.3.9.

~~16.4~~ 4.4 Propulsion control

Existing paragraphs Pt 10, Ch1, 16.4.1 *to* 16.4.5 *have been renumbered* Pt 4, Ch 5, 4.4.1 *to* 4.4.5.

~~16.4.6~~ 4.4.6 Control, alarm and safety systems for the propulsion system are to satisfy the requirements of ~~Pt 9, Ch 1~~ Pt 9, Ch 7 and 8.

Existing paragraphs Pt 10, Ch1, 16.4.7 *to* 16.4.10 *have been renumbered* Pt 4, Ch 5, 4.4.7 *to* 4.4.10.

~~16.4.11~~ 4.4.11 Control systems are not to share hardware or data communication links with control, safety and alarm systems not associated with propulsion control, *see also* ~~Pt 9, Ch 1,2.11~~ Pt 8, Ch 8, 5.2.

~~16.5~~ 4.5 Protection of propulsion system

Existing paragraphs Pt 10, Ch1, 16.5.1 *to* 16.5.5 *have been renumbered* Pt 4, Ch 5, 4.5.1 *to* 4.5.5.

~~16.5.6~~ 4.5.6 For the protection of electrical equipment and cables against overvoltages, means are to be provided for limiting the induced voltage when field windings~~,~~ and other inductive circuits are opened. Protective resistors and devices are to be sized to cater for the likely extreme operating conditions.

Existing paragraph Pt 10, Ch1, 16.5.7 *has been renumbered* Pt 4, Ch 5, 4.5.7.

~~16.5.8~~ 4.5.8 Where, on stopping or reversing the propeller, regenerated energy is produced by the propulsion motor, this is not to cause a dangerous increase of speed in the prime mover or a dangerous overvoltage condition on the supply system. Where a central power generation system is used, then the voltage and frequency fluctuations are not to exceed the limits given in ~~1.8~~ Pt 9, Ch 1, Section 2.

Existing paragraph Pt 10, Ch1, 16.5.9 *has been renumbered* Pt 4, Ch 5, 4.5.9.

~~16.5.10~~ 4.5.10 Loss of flow of air or liquid cooling of propulsion converters, where used, is to initiate an alarm at an attended control position. Loss of flow of air or liquid cooling is not to result in immediate damage to the propulsion converter, *see* ~~9.2.4~~ Pt 9, Ch 3, 7.2.4.

~~16.5.11~~ 4.5.11 Alarms and safeguards for electric propulsion equipment are indicated in Table ~~1.16.1~~ 5.4.1.

Table ~~1.16.1~~ 5.4.1 Electric propulsion equipment: Alarms and safeguards

Item	Alarm	Note
Electric propulsion equipment ventilation and cooling medium temperature	High	*See* ~~16.1.2 and 16.3.8~~ 4.1.3 and 4.3.8
Electric propulsion transformer winding temperature	High	*See* ~~10.1.11~~ Pt 9, Ch 3, 7.11
Electric propulsion generator excitation	Overload	*See* ~~16.5.7~~ 4.5.7
Electric propulsion generators and motors winding temperature	High	*See* ~~16.1.3~~ 4.1.4
Electric propulsion generator and motor lubricating oil temperature	High	*See* ~~9.1.14~~ 4.7.7 and Pt 9, Ch 2, 6.1.4
Electric propulsion generator and motor lubricating oil supply pressure	Low	*See* ~~9.1.13~~ 4.7.6 and Pt 9, Ch 2, 6.1.5
Power limitation	—	Indication, *see* ~~16.4.8 and 16.4.9~~ 4.4.8 and 4.4.9

NOTE
See also IEC 60092-501:2013 Annex A.

~~16.6~~ 4.6 Instruments

Existing paragraphs Pt 10, Ch 1, 16.6.1 *and* 16.6.2 *have been renumbered* Pt 4, Ch 5, 4.6.1 *and* 4.6.2.

4.7 Propulsion motors – general

4.7.1 Propulsion motors are to comply with the general requirements as specified within Ch 3, 6.1.

~~9.1.4~~ 4.7.2 Shaft materials for ~~rotating machines~~ electric propulsion motors ~~for essential services~~ are to comply with the *Rules for Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials) and are to be manufactured under LR survey ~~for the following applications:~~.

~~(a) shaft material for dynamic positioning and electric propulsion motors;~~

~~(b) shaft material for main engine driven generators where the shaft is part of the propulsion shafting; and~~

~~(c) shaft material for machines with power ratings of 250 kW or greater.~~

~~Shaft material for machines with power ratings less than 250 kW is to have a manufacturer’s certificate as detailed in Chapter 1 of the Rules for Materials.~~

~~9.1.10~~ 4.7.3 Propulsion motors ~~and generators~~ that form part of electrical propulsion systems are to have at least one embedded temperature detector (ETD) in each phase of the machine winding in locations which may be subjected to the highest temperature. Where there are two coil sides per slot the ETDs are to be located between the insulated coil sides in the slot, *see* ~~16.1.3~~ 4.1.4.

Existing paragraph Pt 10, Ch1, 9.1.11 *has been renumbered* Pt 4, Ch 5, 4.7.4.

~~9.1.12~~ 4.7.5 A high bearing temperature alarm is to be provided where the ~~following rotating machines~~ electric propulsion motors are supplied with forced lubrication~~:~~
- ~~generators of 100 kW and above; and~~
- ~~electric propulsion motors~~.

~~9.1.13~~ 4.7.6 A low lubricating oil pressure alarm is to be provided for ~~generators and~~ electric propulsion motors that are supplied with forced lubrication.

Existing paragraph Pt 10, Ch1, 9.1.14 *has been renumbered* Pt 4, Ch 5, 4.7.7.

~~9.2~~ 4.8 ~~Rating~~ Propulsion motor ratings

4.8.1 For propulsion motor ratings the applicable requirements of Pt 9, Ch 3, 6.2 are to be complied with.

~~9.2.1~~ 4.8.2 ~~Generators, including their excitation systems, and continuously rated motors are to be suitable for continuous duty at their full rated output at maximum cooling air or water temperature for an unlimited period, without the limits of temperature rise in 9.3 being exceeded. Generators~~ Synchronous propulsion motors are to be capable of an overload power of not less than 10 per cent at their rated power factor for a period of 15 minutes without injurious heating. ~~Other machines are to be rated in accordance with the duty which they have to perform and, when tested under rated load conditions, the temperature rise is not to exceed the values in 9.3.~~

~~9.3~~ 4.9 ~~Temperature rise~~ Propulsion motor temperature rise

4.9.1 For propulsion motor temperature rise the applicable requirements of Pt 9, Ch 3, 6.3 are to be complied with.

~~9.5~~ 4.10 ~~Overloads~~ Propulsion motor overloads

(*Part only shown*)

~~9.5.1~~ 4.10.1 Machines are to withstand on test, without injury, the following momentary overloads:

~~(c) Propulsion machines.~~The overload tests for propulsion machines will be specially considered for each installation.

~~9.6~~ 4.11 ~~Machine enclosure~~ Propulsion motor enclosure

4.11.1 For propulsion motor enclosures the applicable requirements of Pt 9, Ch 3, 6.5 are to be complied with.

~~9.8~~ 4.12 Survey and testing

4.12.1 For survey and testing of propulsion systems the applicable requirements of Pt 9, Ch 1,1.6 and Ch 3,6.7 are to be complied with.

Volume 2, Part 5, Chapter 1

Torsional Vibration

Effective Date 1 January 2015

■ *Section 1* General requirements

1.3 Basic requirements

1.3.3 Where significant changes are subsequently made to a dynamic system which has been approved, (e.g. by changing the original design parameters of the prime movers and/or propulsion shafting system or by fitting a propeller or flexible coupling of different design from the previous), the submission of revised calculations may be required. Details of all such changes are to be submitted for consideration.

■ *Section 2* ~~Details to be submitted~~ Documentation required for design review

2.1 ~~Particulars to be submitted~~ Documentation

Volume 2, Part 5, Chapter 2

Axial Vibration

Effective Date 1 January 2015

■ *Section 2*
~~Details to be submitted~~ Documentation required for design review

2.1 ~~Particulars to be submitted~~ Documentation

Volume 2, Part 5, Chapter 3

Lateral Vibration

Effective Date 1 January 2015

■ *Section 2* ~~Details to be submitted~~ Documentation required for design review

2.1 ~~Particulars to be submitted~~ Documentation

Volume 2, Part 5, Chapter 4

Shaft Alignment

Effective Date 1 January 2015

■ *Section 2*

~~Details to be submitted~~ Documentation required for design review

2.1 **~~Particulars to be submitted for approval~~**
Documentation – Shaft alignment calculations

Volume 2, Part 6, Chapter 1

Steering ~~Arrangements~~ Gear

Effective Date 1 January 2015

■ *Section 1* General requirements

1.1 Application

~~*1.1.3* Attention is to be given to any relevant requirements of the Naval Authority.~~

■ *Section 2* ~~Particulars to be submitted~~ Documentation required for design review

2.1 ~~Submission of information~~ Documentation

2.3 Calculations and information

2.3.1 ~~The~~ A System Design Description which includes the manoeuvring characteristics for which the ship has been designed.

2.3.2 Where ~~the Naval Authority defines~~ rudder roll stabilisation ~~requirements~~ is specified, details of the system are to be submitted. The control engineering systems are to be in accordance with Pt 9, Ch 1.

2.3.5 Noise and vibration acceptance levels for the steering equipment and compartment defined ~~by the Naval Authority~~, where applicable.

■ *Section 5* Design and construction

5.6 Noise and vibration

5.6.1 The reduction of airborne noise, and the structural vibration caused by the steering equipment, is to be regarded as an essential part of the design. The noise and vibration acceptance levels are normally ~~to be defined by the Naval Authority~~ specified for each ship. The techniques to be employed to achieve this are:

(a) Reduction of noise and vibration at source.

(b) Control of noise and vibration transmission paths by use of vibration mounting systems, structural damping, hydraulic silencers and flexible pipes.

■ *Section 7* Electrical power circuits and equipment

7.1 Electrical power circuits, electrical control circuits, monitoring and alarms

7.1.11 Where specified and agreed ~~by the Naval Authority~~, in ships of category NS3, if an auxiliary steering gear is not electrically powered or is powered by an electric motor primarily intended for other services, the main steering gear may be fed by one circuit from the main switchboard. Consideration would be given to other protective arrangements than described in 7.1.1, for such a motor primarily intended for other services.

■ *Section 9* Alternative sources of power and emergency operation

9.1 Alternative sources of power

9.1.2 The alternative power supply shall have a capacity for at least 30 minutes of continuous operation. A greater or lesser period of time may be ~~considered in conjunction with the operational requirements of the Naval Authority~~ specified based on the operational requirements of the ship and any assigned Service Restriction.

Volume 2, Part 7, Chapter 1
Piping Design Requirements

Effective Date 1 January 2015

■ *Section 2*
General

2.1 Documentation required for design review

2.1.1 ~~Documents~~ A System Design Description indicating the following information ~~are~~ is to be submitted for each piping system ~~in triplicate~~:

Design pressure.
Design temperature.
Class of system.
Internal pipe diameter and thickness.
Material specification.
Corrosion protection.
Corrosion allowance.
Pipe connection specifications.
Valve specifications.
Flexible hose specifications.
Expansion piece specifications.
Details of any other pipe fittings.
Pumping unit type and discharge characteristics.
Testing procedures.
~~Design statements~~ System Design Descriptions for heat exchangers as required by 18.1.11.

2.1.2 Where the Owner~~/Operator~~ has specified requirements for the life of a particular piping system under defined operating conditions, details of enhanced pipe scantlings and assumptions made are to be submitted for review.

2.2 Definitions

(*Part only shown*)
2.2.1 **Essential piping systems** are those systems installed for the propulsion and safety of the ship within the Mobility category and Ship Type category (*see* Pt 1, Ch 1,3) and include the following:

Hydraulic oil systems for:
steering gears;
controllable pitch propellers;
thrust units for propulsion ~~and/or dynamic positioning~~;
windlass machinery;
watertight bow, stern, side and internal doors;
valve control systems, etc.

■ *Section 3*
Assessment

3.1 Design and construction

3.1.6 Pipe thicknesses greater than the minimum required by this Chapter may be necessary where the likelihood of erosion cannot be avoided and/or where there is a likelihood of corrosion exceeding the nominal allowances specified in the Rule requirements. Pipe thicknesses may also need to be increased where the Owner~~/Operator~~ has specified requirements for system life, *see* 2.1.2.

■ *Section 4*
Materials

4.1 Metallic materials

4.1.4 ~~The Manufacturer's materials certificate will be accepted for Class III piping systems and for all other classes of piping and associated components in lieu of an LR materials certificate where either of the maximum design conditions is less than the values shown in Table 1.4.1. *See* Ch 1,3.1.3(c) of the Rules for Materials.~~ The Manufacturer's materials certificate will be accepted in lieu of an LR materials certificate for Class III piping systems and for all other classes of piping and associated components where the maximum design conditions are less than the values shown in Table 1.4.1. *See* Ch 1,3.1.3(c) of the Rules for Materials.

Table 1.4.1 Maximum conditions for pipes, valves and fittings for which manufacturer's materials test certificate is acceptable

Material	~~Working temperature °C~~	DN = Nominal diameter, mm P_W = Working pressure, bar
~~Carbon and low alloy steel.~~ ~~Stainless steel.~~ ~~Spheroidal or nodular cast iron.~~ When the working temperature is less than 300°C: Carbon and low alloy steel, austenitic stainless steel and cast iron (spheroidal or nodular)	~~< 300~~	$DN < 50$ or $P_W \times DN < 2500$
Copper alloy intended for a working temperature of less than 200°C	~~< 200~~	$DN < 50$ or $P_W \times DN < 1500$

■ *Section 5*
Pipe connections

5.6 Socket weld joints

5.6.1 Socket weld joints may be used in Class III systems with carbon steel pipes of any outside diameter. Socket weld fittings are to be of forged steel and the material is to be compatible with the associated piping. In particular cases, socket weld joints may be permitted for piping systems of Class I and II having outside diameter not exceeding 88,9 mm. Such joints are not to be used where fatigue, severe erosion or crevice corrosion is expected to occur or where toxic or asphyxiating media are conveyed, other than for carbon dioxide fire-extinguishing distribution piping.

5.6.4 Socket weld joints may be used in carbon dioxide fire-extinguishing system distribution piping only as permitted by 5.11.

5.10 Mechanical connections for piping

5.10.13 Mechanical joints are to be tested in accordance with ~~a program approved by LR~~ the test requirements in LR Test Specification Number 2, which is to include the following tests as relevant to the service conditions and the intended application:

- leakage test;
- vacuum test;
- vibration (fatigue) test;
- fire endurance test;
- burst pressure test;
- pressure pulsation test;
- reassembly test;
- pull out test;
- static displacement/misalignment test.

5.11 Carbon dioxide (CO2) fire-extinguishing system piping

5.11.1 The piping for carbon dioxide fire-extinguishing systems is to comply with the requirements of Chapter 5 of the FSS Code, as applicable. For purposes of classification, any use of the word 'Administration' in the FSS Code is to be taken to mean LR.

5.11.2 Materials for the distribution manifolds between the carbon dioxide storage bottles and the discharge valves to each section and associated pipes, valves and fittings of high pressure systems are to be manufactured and tested in accordance with the requirements for Class I piping systems. Pipes are to meet the minimum wall thickness requirements of Table 1.6.4 and the manifold system is to be hydraulically tested to a pressure of 190 bar. A high pressure system is defined as a system where the carbon dioxide is stored at ambient temperature. Materials for the distribution manifolds between the carbon dioxide storage vessel(s) and the discharge valves to each section and associated pipes, valves and fittings of low pressure systems are to be manufactured and tested in accordance with the requirements for Class II piping systems and the manifold system is to be hydraulically tested to a pressure of 33 bar. A low pressure system is defined as a system where the carbon dioxide is stored at a working pressure in the range of 1,8 N/mm^2 to 2,2 N/mm^2.

5.11.3 Piping downstream of the distribution valve(s) for high pressure systems is to be manufactured and tested in accordance with the requirements for Class II piping and is to meet the minimum wall thickness requirements of Table 1.6.4. After installation the distribution system is to be leak tested at a pressure of 6 bar.

Piping downstream of the distribution valve(s) for low pressure systems is to be manufactured and tested in accordance with the requirements for Class III piping. After installation the distribution system is to be leak tested at a pressure of 6 bar.

Class III piping may be used for open-ended distribution piping downstream of the distribution valve(s) of high pressure systems where agreed by LR and where meeting the minimum wall thickness requirements of Table 1.6.4 and where a minimum of ten per cent of the piping is hydraulically tested at a pressure of 125 bar. This testing is to be carried out before installation.

5.11.4 Any part of the carbon dioxide fire-extinguishing system piping is to be of galvanised steel or of corrosion-resistant steel. Where full penetration butt welding is used, the pipe is to be protected against corrosion in the area of the weld seam after welding. The process for protecting the pipe internally against corrosion is to be of an approved type.

All pipes are to be arranged to be self-draining. Where pipes are to be led into refrigerated spaces, this is subject to special consideration. The ends of distribution pipes downstream of the distribution valve(s) are to extend at least 50 mm beyond the last nozzle and are to be fitted with a dirt trap consisting of an open-ended tee with a capped nipple.

5.11.5 If it is necessary for carbon dioxide pipes to pass through accommodation spaces, the pipe is to be seamless and is to meet the requirements for Class II pipes. Joints are to be made only by welding and the pipes are to be hydraulically tested after installation at a pressure of 50 bar.

5.11.6 The following means are permitted for making joints on carbon dioxide fire-extinguishing system piping;

(a) Full penetration butt welding, where the pipe is galvanised, *see* 5.11.4.
(b) Couplings as permitted by Table 1.5.3.
(c) Cone connections.
(d) Tapered screw joints, where allowed by 5.11.9 and where meeting the requirements of 5.11.9.
(e) Flanged joints.
(f) Socket weld joints to acceptable National Standards and where allowed by 5.11.7 and where meeting the requirements of 5.11.8.

5.11.7 Socket weld joints of an approved type may be used downstream of the distribution valve(s), provided that the requirements for materials and limitations on outside diameter applicable for Class II piping are applied.

5.11.8 Where socket weld joints are utilised, the pipes in the way of the weld joints are to be adequately supported and the joints are to be located where they are visible. Where welding is to be carried out in situ, the piping is to be kept clear of adjacent structures to allow sufficient access for preheating and welding, which is to be carried out in accordance with approved procedures.

5.11.9 Threaded joints are only allowed inside protected spaces and in carbon dioxide bottles storage rooms. They should have no exposed screw threads and any thread sealing medium should be selected as to ensure no protrusions or debris might be produced into the pipe.

■ *Section 11*
Pipe connections

11.1 General

11.1.7 The use of plastics pipes may be restricted, as specified by the ~~Naval Authority~~ Naval Administration.

11.1.8 Where ~~it is proposed to use~~ there is a restriction on the use of plastics materials for piping systems and associated equipment installed in naval ships, the ~~Naval Authority may require~~ Naval Administration may allow their use following a Risk Assessment, in accordance with Pt 1, Ch 2,17~~, to be submitted~~ that addresses the following:

(a) the potential fire risks in the space containing the plastics materials;
(b) The effect of a fire in the compartment containing plastics materials in terms of fire spread and of producing excessive quantities of smoke and toxic products.
(c) An engineering justification for the use of plastics materials in preference to metallic materials which are not sensitive to heat.

11.4 Fire performance criteria

11.4.4 The ~~Naval Authority~~ Naval Administration may specify to extend the requirements of 11.4.3 to apply to on equipment piping in machinery spaces. *See also* 11.1.8.

■ *Section 13*
Flexible hoses

13.4 Testing

13.4.2 For a particular hose type complete with end fittings, the tests, as applicable, are to be carried out on different nominal diameters for pressure, burst, impulse and fire resistance in accordance with the requirements of the relevant standard. The following standards are to be used as applicable:

- ISO 6802 – *Rubber and plastics hoses and hose assemblies with wire reinforcements – Hydraulic ~~pressure~~ impulse test ~~without~~ with flexing*.
- ISO 6803 – *Rubber ~~and~~ or plastics hoses and hose assemblies – Hydraulic pressure impulse test ~~with~~ without flexing*.
- ISO 15540 – *Ships and marine technology – Fire resistance of hose assemblies – Test methods.*
- ISO 15541 – *Ships and marine technology – Fire resistance of hose assemblies – Requirements for test bench.*
- ISO 10380 – *Pipework – Corrugated metal hoses and hose assemblies.*

Other standards may be accepted where agreed by LR.

■ *Section 18*
Heat exchangers

18.1 General

18.1.6 Heat exchangers are to be capable of stable operation at their specified rating under all envisaged operating conditions, *see* Pt 1, Ch 2,4. Any degraded performance under extreme environmental operating conditions is to be stated by the manufacturer and included in the ~~design statement~~ System Design Description required by 18.1.11.

18.1.11 A ~~design statement~~ System Design Description for each size and type of heat exchanger used in Mobility and Ship Type engineering systems is to be submitted for information purposes. The ~~design statement~~ System Design Description is to include details of margins for fouling and plugging of tubes where applicable.

Volume 2, Part 7, Chapter 2

Ship Piping Systems

Effective Date 1 January 2015

■ *Section 1* General requirements

1.1 Application

~~*1.1.2* Attention is to be given to any relevant requirements of the Naval Authority.~~

Existing paragraphs 1.1.3 *to* 1.1.4 *have been renumbered* 1.1.2 *to* 1.1.3.

1.2 ~~Plans and particulars~~ Documentation required for design review

1.2.1 At least three copies of the following plans (in diagrammatic form) and ~~particulars are~~ a System Design Description containing the additional information are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of a novel or special character affecting classification:

- Arrangements of air pipes and closing appliances to tanks and enclosed spaces.
- Sounding arrangements for all tanks and enclosed spaces.
- Arrangements of level alarms fitted in tanks, machinery spaces and any other spaces.
- Arrangements of any cross-flooding or heeling tank systems.
- Bilge drainage and dewatering arrangements to all compartments which are to include details of location, number and capacity of pumping units on bilge and dewatering service.
- Ballast filling and drainage arrangements. The submission should include a schematic piping drawing showing connection of the ballast water treatment system, where fitted, to the ballast filling and drainage arrangement.
- Tank overflow arrangements.
- Details verifying compliance with the sizing of air pipes required by 10.8.
- Details verifying compliance with 10.3.3 for tanks that can be replenished at sea with design ship movements and filling rates stated.
- Operating manuals and maintenance instructions are to be provided on board and submitted for information where requested by Lloyd's Register (hereinafter referred to as 'LR'). The manuals are to include particulars, description, operating instructions and maintenance instructions for all systems.

■ *Section 9* Additional requirements relating to fixed pressure fire-extinguishing systems

9.1 Bilge drainage requirements

(*Part only shown*)

9.1.1 Where arrangements for cooling underdeck hold spaces, or fire-fighting by means of fixed spraying nozzles or by flooding of spaces with water are provided, the drainage arrangements are to be such as to be effective under all normal angles of heel and trim. The following provisions are also to be satisfied:

(c) Adequately sized bilge wells are to be located at the side shell of the ship at a distance of not more than 40 m in each watertight compartment, *see also* Vol 1, Pt 3, Ch 4,8.1.4 and Vol 1, Pt 4, Ch 3,2.11. In ships other than NS3 Ships and vessels designed to carry less than 50 embarked personnel, if it is not possible to locate the bilge wells as required, the free surface effect on the ship's stability is to be determined ~~and submitted to the Naval Authority for appraisal~~.

■ *Section 10* Air, overflow and sounding pipes

10.6 Air pipe closing appliances

10.6.1 The closing appliances fitted to tank air pipes in accordance with Vol 1, Pt 3, Ch 4,7.2 are to be of an automatic opening type which will allow the free passage of air or liquid to prevent the tanks being subjected to a pressure or vacuum greater than that for which they are designed, and prevent the free entry of water into the tanks.

10.6.2 Air pipe closing devices are to be of a type acceptable to LR and are to be tested in accordance with ~~a National or International Standard recognised by LR~~ the test requirements in LR Test Specification Number 2. The flow characteristics of the closing device are to be determined using water. *See* 10.8.1.

10.6.9 In the case of air pipe closing devices of the float type, suitable guides are to be provided to ensure unobstructed operation under all working conditions of heel and trim as specified in 10.6.4.

Volume 2, Part 7, Chapter 3
Machinery Piping Systems

Effective Date 1 January 2015

■ *Section 1*
General requirements

1.2 ~~Plans and particulars~~ Documentation required for design review

(*Part only shown*)

1.2.1 Three copies of the following plans (in diagrammatic form) and ~~particulars are~~ a System Design Description containing the additional information are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of novel or special character affecting classification:

■ *Section 2*
Oil fuel – General requirements

2.1 Flash point

(*Part only shown*)

2.1.3 ~~In general, oil~~ Oil fuel in storage ~~and service~~ tanks is not to be heated to a temperature exceeding 10°C below its flash point. Higher temperatures will be considered for oil fuel stored in settling and service tanks where:

(c) ~~There is no source of ignition in the vicinity of the ventilation pipes or near the openings in the drainage systems or in the tanks themselves.~~ The length of vent pipes from such tanks and/or a cooling device is sufficient for cooling oil vapours to below 60°C, or the outlet of the vent pipes is located at least 3 m from sources of ignition.

(d) There is no source of ignition in the vicinity of openings in the drainage systems.

(e) There are no openings from the vapour space of the fuel tanks into machinery spaces other than bolted sealed manhole covers.

(f) Enclosed spaces are not located directly over such fuel tanks, except for vented cofferdams.

(g) Electrical equipment is not fitted in the vapour space of tanks unless it meets the requirements of Vol 2, Pt 10, Ch 1,14.2.4 for electrical equipment in zone 0 explosive atmospheres.

2.9 Precautions against fire

2.9.13 Where level switches are used below the tank top, they are to be contained in a steel enclosure or other enclosures which provide an equivalent protection against fire.

■ *Section 3*
Oil fuel burning arrangements

3.1 Oil burning units

3.1.1 All oil burning equipment is to be capable of operating at defined power/rating levels where specified ~~by the Naval Authority~~. Confirmation by the manufacturer of this capability is to be provided to LR, including the specified power/rating parameters, and operating and maintenance regimes. *See also* Pt 1, Ch 2,4.1.2.

3.11 Booster pumps when operating in emissions control areas

3.11.1 Ships intending to use Heavy Fuel Oil (HFO) or Marine Diesel Oil (MDO) when operating outside emissions control areas and marine fuels with a sulphur content not exceeding 0,1 per cent m/m and minimum viscosity of 2 cSt when operating inside emission control areas are to meet the requirements of 3.11.2 or 3.11.3.

3.11.2 The booster pumps which are fitted in compliance with 3.10 are acceptable for use in emissions control areas where these pumps are each suitable for marine fuels with a sulphur content not exceeding 0,1 per cent m/m and minimum viscosity of 2 cSt operation at the required capacity for normal operation of propulsion machinery.

3.11.3 When the booster pumps which are fitted in compliance with 3.11.2, and one pump alone is not capable of delivering marine fuels with a sulphur content not exceeding 0,1 per cent m/m and minimum viscosity of 2 cSt at the required capacity, two booster pumps may operate in parallel to achieve the required capacity for normal operation of propulsion machinery. In this case, one additional fuel oil supply pump is to be provided. The additional booster pump shall, when operating in parallel with one of the booster pumps in 3.10, be suitable for and capable of delivering marine fuels with a sulphur content not exceeding 0,1 per cent m/m and minimum viscosity of 2 cSt at the required capacity for normal operation of the propulsion machinery.

Existing sub-Section 3.11 *has been renumbered* 3.12.

■ *Section 4*
Oil fuel pumps, pipes, fittings, tanks, etc.

4.13 Alternative carriage of oil fuel and water ballast

4.13.2 Attention is drawn to ~~the requirements of the Naval Authority in connection with prevention of pollution of the sea by oil~~ regulations that may be specified by the Naval Administration in connection with the *International Convention for the Prevention of Pollution of the Sea by Oil, 1973/78*.

4.17 Oil fuel service tanks

4.17.3 A greater or lesser period than the 8 hour period specified in 4.17.2 may be considered in conjunction with the operational requirements of the ~~Naval Authority~~ ship and any assigned Service Restriction.

4.18 Water compensated oil fuel tanks

4.18.1 The use of water compensated oil fuel tanks is to be avoided whenever practicable and attention is drawn to regulations that may be specified by the ~~Naval Authority~~ Naval Administration in connection with the *International Convention for the Prevention of Pollution of the Sea by Oil, 1973/78*.

4.18.2 Where the ship design considerations require the inclusion of sea-water compensated oil fuel tanks the arrangements are to comply with the requirements in 4.18.3 to 4.18.13. Acceptance of water compensated oil fuel tanks is subject to the provision of alternative oil fuel storage and usage arrangements that do not rely only on the use of water compensated tanks and that permit oil fuel to settle before use. The arrangement and capacity of oil fuel in tanks that do not have sea-water compensation arrangements are to recognise the service profile required by Pt 1, Ch 2,3.3.2~~ and be acceptable to the Naval Authority~~.

4.18.10 The design oil fuel filling and sea-water discharge flow rates are to be ~~agreed~~ specified by the ~~Naval Authority~~ Naval Administration. The oil fuel filling rate is to be achieved by use of filling trunks or other regulating method that will always provide sufficient head of oil to displace water from the water compensated fuel tanks and prevent a tank being subjected to a pressure greater than that for which it has been designed.

■ *Section 8*
Lubricating oil systems

8.7 Maintenance of bearing lubrication

8.7.4 The capacity of lubricating oil service tanks is to be sufficient to avoid the need to replenish a tank for ~~an agreed~~ a period of time ~~(designer/Owner/Operator)~~ agreed by the Owner, assuming the normal oil consumption rate quoted by the equipment manufacturer.

8.8 Filters

8.8.3 Centrifuges used for lubricating oil treatment are to be type tested for use on board ships in accordance with a national or international standard that is acceptable to LR.

8.9 Filling arrangements

~~*8.9.2* Provision is to be made against over-pressure in the filling pipelines. Any relief valve fitted for this purpose is to discharge to an overflow tank or other safe position and is to be sized to allow full flow of supply through the relief valve without over-pressuring the upstream pipe work.~~

8.15 Deep tank valves and their control arrangements

8.15.1 The requirements for remote operation on valves on deep tank suction pipes may be waived where the valves are closed during normal operation ~~where agreed by the Naval Authority~~.

■ *Section 11*
Electrical equipment cooling arrangements

11.1 General

11.1.4 The possible formation of condensation due to low cooling temperatures where high humidity is likely to occur within electrical enclosures is also to be taken into account. The ambient temperatures and anticipated humidity levels are to be declared in the ~~design statement~~ System Design Description required by 11.1.9.

11.1.9 A ~~design statement~~ System Design Description for cooling systems for electrical equipment used in Mobility and Ship Type category engineering systems is to be submitted for information purposes.

■ *Section ~~7~~ 12*
Air compressors and air starting arrangements

The amends shown in Section 12 have been moved from Pt 2, Ch 1, Section 7.

~~7.1~~ 12.1 General requirements

~~7.1.1~~ 12.1.1 The requirements of this Section are applicable to reciprocating air compressors intended for starting main engines and auxiliary engines providing essential services and are applicable to both diesel engines and gas turbine engines.

~~7.1.2~~ 12.1.2 Two or more air compressors are to be fitted having a total capacity, together with a topping-up compressor where fitted, capable of charging the air receivers within one hour from atmospheric pressure to the pressure sufficient for the number of starts required by ~~7.12~~ 12.12. At least one of the air compressors is to be independent of the main propulsion unit and the capacity of the main air compressors is to be approximately equally divided between them. The capacity of an emergency compressor which may be installed to satisfy the requirements of ~~7.11~~ 12.11 is to be ignored.

Existing paragraphs Pt 2, Ch 1, 7.1.3 *to* 7.1.5 *have been renumbered* Pt 7, Ch 3, 12.1.3 *to* 12.1.5.

~~7.1.6~~ 12.1.6 Where starting air is provided from a general use compressed air system, it is to be demonstrated that the system capacities are consistent with the philosophy described in ~~7.1.2~~ 12.1.2.

~~7.2~~ 12.2 Plans and particulars

Existing paragraph Pt 2, Ch 1, 7.2.1 *has beeen renumbered* Pt 7, Ch 3, 12.2.1.

~~7.2.2~~ 12.2.2 Where compressors of a special type or design are proposed, the requirements of Pt 7, Ch 15 of the ~~*Rules and Regulations for the Classification of Ships*~~ Rules for Ships are to be applied.

~~7.3~~ 12.3 Materials

Existing paragraph Pt 2, Ch 1, 7.3.1 *has been renumbered* Pt 7, Ch 3, 12.3.1.

~~7.3.2~~ 12.3.2 Where it is proposed to use materials outside the ranges specified in ~~7.3.1~~ Pt 2, Ch1, 3.2.1, details of the chemical composition, heat treatment and mechanical properties are to be submitted for approval.

~~7.3.3~~ 12.3.3 Materials for components are to be tested as indicated in Pt 2, Ch 1, 3.1.

~~7.3.4~~ 12.3.4 For crankshafts with a calculated crankpin diameter equal to or greater than 50 mm, they are to be manufactured and tested in accordance with the requirements of LR's ~~*Rules for the Manufacture, Testing and Certification of Materials* (herein after referred to as the~~ Rules for Materials~~)~~. For calculated crankpin diameters less than 50 mm, a manufacturer's certificate may be accepted, see Ch 1,3.1.3(c) of the Rules for Materials.

~~7.4~~ 12.4 Design and construction

~~7.4.1~~ 12.4.1 A fully documented fatigue strength analysis is to be submitted, indicating a factor of safety of 1,5 at the design loads, based on a suitable fatigue strength criterion. Alternatively, the requirements of ~~7.4.2 to 7.4.6~~ 12.4.2 to 12.4.6 may be used.

~~7.4.2~~ 12.4.2 The diameter, *dp*, of a compressor crankshaft is to be not less than *d*, determined by the following formula, when all cranks on the shaft are located between two main bearings only:

$$d = V_c \left(\frac{D^2 p Z}{78,5} \left(\frac{S}{16} + \frac{a\,b}{a+b} \right) \right)^{1/3} \text{ mm}$$

where

a = distance between inner edge of one main bearing and the centreline of the crankpin nearest the centre of the span, in mm

b = distance from the centreline of the same crankpin to the inner edge of the adjacent main bearing, in mm

$a + b$ = span between inner edges of main bearings, in mm

d_p = proposed minimum diameter of crankshaft, in mm

p = design pressure, in bar g, as defined in Pt 7, Ch 1,3.3.1

D = diameter of cylinder, in mm

S = length of stroke, in mm

V_c = 1,0 for shafts having one cylinder per crank, or

$$\left.\begin{array}{l} = 1,05 \text{ for } 90^\circ \\ = 1,18 \text{ for } 60^\circ \\ = 1,25 \text{ for } 45^\circ \end{array}\right\} \text{between adjacent cylinders on the same crankpin}$$

for the shaft and cylinder arrangements as detailed in Table ~~1.7.1~~ 1.12.1

$$Z = \frac{560}{\sigma_u + 160} \quad \text{for steel}$$

$$Z = \frac{700}{\sigma_u + 260 - 0,059 d_p} \quad \text{for spheroidal or nodular graphite cast iron}$$

$$Z = \frac{700}{\sigma_u + 260 - 0,069 d_p} \quad \text{for grey cast iron}$$

σ_u = specified minimum tensile strength of crankshaft material, in N/mm^2.

Table ~~1.7.1~~ 1.12.1 Angle between cylinders

Existing paragraphs Pt 2, Ch 1, 7.4.3 *and* 7.4.6 *to* 7.4.12 *have been renumbered* Pt 7, Ch 3, 12.4.3 *and* 12.4.6 *to*12.4.12.

~~7.4.4~~ 12.4.4 The dimensions of crankwebs are to be such that $B\ t^2$ is to be not less than given by the following formulae:

$0,4d^3$ for the web adjacent to the bearing
$0,75d^3$ for intermediate webs

where

B = breadth of web, in mm
d = minimum diameter of crankshaft as required by ~~7.4.2~~ 12.4.2, in mm
t = axial thickness of web which is to be not less than $0,45d$ for the web adjacent to the bearing, or $0,60d$ for intermediate webs, in mm.

~~7.4.5~~ 12.4.5 Fillets at the junction of crankwebs with crankpins or journals are to be machined to a radius not less than $0,05d$. Smaller fillets, but of a radius not less than $0,025d$, may be used, provided the diameter of the crankpin or journal is not less than cd:

where

$c = 1,1 - 2\dfrac{r}{d}$ but to be taken as not less than 1,0
d = minimum diameter of crankshaft as required by Pt 2, Ch 1, 8.4.2, in mm
r = fillet radius, in mm.

Existing sub-Sections Pt 2, Ch 1, 7.5 *to* 7.6 *have been renumbered* Pt 7, Ch 3, 12.5 *to* 12.6.

Existing paragraphs Pt 2, Ch 1, 7.7.1 *to* 7.7.5 *and* 7.7.8 *have been renumbered* Pt 7, Ch 3, 12.7.1 *to* 12.7.5 *and* 12.7.8.

~~7.7~~ 12.7 Crankcase relief valves

~~7.7.6~~ 12.7.6 A copy of the installation and maintenance manual required by ~~7.7.3~~ 12.7.3 is to be provided on board the ship.

~~7.7.7~~ 12.7.7 Plans showing details and arrangements of the crankcase relief valves are to be submitted for approval, *see* Pt 2, Ch 1, 2.1 and Pt 3, Ch 2, 5.2.5.

~~7.8~~ 12.8 Number of crankcase relief valves

~~7.8.1~~ 12.8.1 In compressors having cylinders exceeding 200 mm but not exceeding 250 mm bore, at least two relief valves are to be fitted~~;~~. ~~where~~ Where more than one relief valve is required, the valves are to be located at or near the ends of the crankcase.

Existing paragraphs Pt 2, Ch 1, 7.8.2 *to* 7.8.4 *have been renumbered* Pt 7, Ch 3,12.8.2 *to* 12.8.4.

Existing sub-Sections Pt 2, Ch 1,7.9 *to* 7.10 *have been renumbered* Pt 7, Ch 3,12.9 *to* 12.10.

~~7.11~~ 12.11 Dead ship condition starting arrangements

Existing paragraphs Pt 2, Ch 1, 7.11.1, 7.11.3 *to* 7.11.5 *have been renumbered* Pt 7, Ch 3, 12.11.1, 12.11.3 *to* 12.11.5.

~~7.11.2~~ 12.11.2 Dead ship condition for the purpose of ~~7.11.1~~ 12.11.1 is to be understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation. In restoring propulsion, no stored energy for starting and operating the propulsion plant is assumed to be available. Additionally, neither the main source of electrical power nor other essential auxiliaries is assumed to be available for starting and operating the propulsion plant.

Existing sub-Section Pt 2, Ch 1,7.12 *has been renumbered* Pt 7, Ch 3, 12.12.

~~7.13~~ 12.13 Starting air pipe systems and safety fittings

~~7.13.1~~ 12.13.1 Air start piping systems are, in general, to comply with the requirements of Pt 7, Ch 1, with due regard being paid to the particular type of installation.

Existing paragraphs Pt 2, Ch 1, 7.13.2 *to* 7.13.8 *have been renumbered* Pt 7, Ch 3,12.13.2 *to* 12.13.8.

12.13.9 The requirements for battery installations are given in Pt 10, Ch 1.

NOTES
Existing sub-Section Pt 2, Ch 1, 7.14 *has been renumbered* Pt 2, Ch 1, 7.2.
Existing sub-Section Pt 2, Ch 1, 7.16 *has been renumbered* Pt 2, Ch 1, 7.4.

Volume 2, Part 7, Chapter 4

Aircraft/Helicopter/Vehicle Fuel Piping and Arrangements

Effective Date 1 January 2015

■ *Section 1*

General requirements

1.1 Application

1.1.1 This Chapter covers the requirements for piping systems and arrangements in naval ships for bunkering, storing and distribution of fuel for aircraft/helicopters and diesel engined vehicles that are part of the ship's operational equipment. ~~The requirements are not applicable to the storage of petrol.~~

1.1.5 The requirements of the Naval ~~Authority are also be taken into consideration.~~ Administration and standards for NATO interoperability~~, if any,~~ are to be specified by the Owner~~/Operator~~.

1.1.6 Electrical arrangements are to comply with Pt 10, Ch 1 as applicable. Attention is drawn to Pt 10, Section ~~13~~ 14 where it is intended to carry fuel with a flash point not exceeding 60ºC.

1.2 ~~Plans and particulars~~ Documentation required for design review

1.2.2 ~~Design statement.~~ System Design Description. A ~~design statement~~ System Design Description is to be submitted for information, *see* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5.

■ *Section 2*

Refuelling facilities

2.1 Fuel storage

2.1.2 Storage tanks can be integral tanks or independent tanks and shall ~~are to~~ be located in a designated area ~~as remote as practicable from machinery and accommodation stations~~. Tanks shall be segregated from accommodation, service and machinery spaces ~~and be suitably isolated from areas where there are sources of ignition~~ by provision of a cofferdam, *see* 2.1.10.

2.1.3 Where independent fuel tanks in accordance with the requirements of 2.2 are fitted, the compartment is to comply with the requirements of Pt 10, Ch 1 for hazardous zones, ventilation and access arrangements.

Existing paragraphs 2.1.3 *to* 2.1.7 *have been renumbered* 2.1.4 *to* 2.1.8.

~~*2.1.8*~~ *2.1.9* Tanks are to be provided with ~~an intrinsically safe level indicator~~ a level indicator that is fitted through the top of the tank and certified for installation in the appropriate hazardous zone. *See* Pt 10, Ch 1, Section 14.

~~*2.1.9*~~ *2.1.10* Cofferdams are to be provided between tanks and ~~non-dangerous~~ spaces~~, such as machinery spaces (for guidance of definitions of dangerous spaces refer to Pt 10, Ch 1)~~ containing sources of ignition.

Existing paragraphs 2.1.10 *to* 2.1.17 *have been renumbered* 2.1.11 *to* 2.1.18.

~~*2.1.18*~~ *2.1.19* The use of water compensated fuel tanks for fuel supply to aircraft and helicopters is not permitted. Wherever practicable they are to be avoided for fuel supply to diesel engined vehicles. Attention is drawn to regulations that may be specified by the ~~Naval Authority~~ Naval Administration in connection with the *International Convention for the Prevention of Pollution of the Sea by Oil, 1973/78*. Where ship design considerations require the use of such tanks, the requirements of Ch 3,4.18 are applicable.

~~*2.1.19*~~ *2.1.20* *See* Pt 10, ~~Ch 1,1.12~~ Ch 1,1.14 for requirements for control of static electricity.

2.1.21 Where it is intended to temporarily carry fuel with a flash point not exceeding 60ºC, this shall be stored in a designated area which shall comply with 2.1.3.

2.3 Fuel pumping and filling

2.3.11 Suitable filtration arrangements are to be provided to reduce the level of water and particulate contamination of the fuel to within the limits specified by the Owner~~/Operator~~.

2.5 Defuelling

2.5.1 Arrangements are to be made to ensure that only fuel having a flash point equal to or greater than the flash point for which the ship has been designed and approved for is discharged into the ship's fuel storage system. Arrangements and equipment are to be provided to ensure that if defuelling of aircraft/helicopters carrying fuel having a flash point less than 60°C is required, the fuel flash point is increased to a figure above 60°C before discharge into the ship's storage system. Fuel from aircraft/helicopters may also be contaminated and to provide segregation before discharge to the ship's storage system, a separate recovery tank for handling this fuel is to be provided. The capacity of the recovery tank is to be sufficient to safely handle the fuel from an aircraft/helicopter and is to be identified in the ~~design statement~~ System Design Description required by 1.2.2.

Volume 2, Part 7, Chapter 5
Ship Type Piping Systems

Effective Date 1 January 2015

■ *Section 1*
General requirements

1.1 General

~~*1.1.3* The Naval Authority may impose requirements additional to those in this Chapter.~~

1.2 Scope

1.2.2 Other systems defined as Ship Type category engineering systems, *see* Pt 1, Ch 1,3.1.3, as specified ~~identified by the Naval Authority~~.

1.3 ~~Plans and information~~ Documentation required for design review

1.3.2 ~~Design statement~~. System Design Description. A ~~design statement~~ System Design Description of each Ship Type piping system, *see* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5.

■ *Section 2*
Construction and installation

2.3 Piping and equipment – Selection and installation

2.3.1 Air receivers and gas pressurised hydraulic accumulators are to be in accordance with Pt 8, Ch 2 or a recognised Code ~~and satisfy the Naval Authority's revalidation system for such items~~, where applicable. Materials used in the construction are to be manufactured and tested in accordance with the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials).

■ *Section 3*
System arrangements

3.1 Piping systems

3.1.3 The design of piping systems is to recognise operational and manning philosophy for the vessel and is to be declared in the ~~design statement~~ System Design Description required by 1.3.2.

■ *Section 5*
Risk assessment (RA)

5.1 General

5.1.2 The RA is to establish that the system retains a level of operational capability as defined in the ~~design statement~~ System Design Description required by 1.3.2, following failure or damage of pipework, an item of equipment or the loss of a compartment.

■ *Section 6*
Testing and trials

6.3 Trials

6.3.1 Trials are to be carried out to demonstrate the capability of systems to meet ~~design statements~~ System Design Descriptions. The trials are as far as practicable to be representative of the actual conditions to be encountered in service.

■ *Section 7*
Chilled water systems

7.1 General

7.1.3 The refrigeration plant and chilled water system is to be designed to be capable of continuously extracting at least 115 per cent of the maximum heat load duty when operating at the conditions stated in the ~~design statement~~ System Design Description required by 1.3.2.

7.1.4 The demineralised water used in chilled water distribution systems is to be in accordance with the system designer's specification that typically would include the following limitations:

- Conductivity: <4,5 micromhs/cm^3
- Dissolved solids: Zero
- Alkalinity: pH 7,1
- Suspended solids: <2,5 ppm with particle size <250 microns

The specification for demineralised water is to be agreed by the Owner~~/Operator~~.

7.2 Refrigeration plant

7.2.1 Two or more independent refrigeration plants are to be provided and designed to be capable of extracting the heat load duty required by 7.1.3 when operating at the conditions stated in the ~~design statement~~ System Design Description with any one plant out of action.

7.2.2 The refrigeration plants are to be located in separate compartments and zones such that the loss of one compartment or zone, or failure in equipment will not render the other refrigeration plant(s) inoperative. In NS3 category ships the requirement for pumps to be located in separate zones will not be insisted on where agreed by the Owner~~/Operator~~ and included in the ~~design statement~~ System Design Description.

7.3 Water system

7.3.1 Two or more chilled water pumps are to be provided and be of sufficient capacity to circulate chilled water at the flow rate and conditions stated in the ~~design statement~~ System Design Description with any one pump out of action.

7.3.2 The chilled water pumps are to be located in separate compartments and zones such that loss of one compartment or zone or failure in equipment will not render the chilled water system inoperative.

NOTE

This does not preclude locating the chilled water pumps in the same compartment as the refrigeration plants mentioned in 7.2. Plants and their associated chilled water pumps are to be arranged such that the pumps can be cross-connected to other plants in the event of plant or pump failure. In NS3 category ships the requirement for pumps to be located in separate zones will not be insisted on where agreed by the Owner~~/Operator~~ and included in the ~~design statement~~ System Design Description.

7.3.7 Provision is to be made for filling and topping up the chilled water system. A means is also to be provided for connecting the system to a dry main for shore connection above the waterline. The shore connection is to be sized sufficient to enable supply of cooling water for the ship's requirement as declared in the ~~design statement~~ System Design Description required by 1.3.2.

7.3.9 Sea-water systems for refrigeration condensers are to be capable of being supplied from not less than two ~independent sources located in separate compartments and zones such that the loss of one compartment or zone, or failure in equipment will not render loss of all sea-water sources. In NS3 category ships the requirement for refrigeration condensers to be located in separate zones will not be insisted on where agreed by the Owner~~/Operator~~ and included in the ~~design statement~~ System Design Description.

7.3.10 The capacity of each source of sea-water required by 7.3.9 is to be sufficient for the conditions stated in the ~~design statement~~ System Design Description with any one source out of action.

■ *Section 8*
High pressure compressed air systems

8.1 General

8.1.2 High pressure (HP) compressed air systems are to produce and distribute compressed air throughout the ship to supply all systems and equipment where the air pressure requirement exceeds 7 bar. The systems are to include air compressors, oil/water separators, filter/dryers, distribution lines and air receivers. For the purpose of ~~Naval Authority~~ maintenance and safety regulatory requirements, HP air systems may be defined as those where the air pressure requirements exceed 25–40 bar and this is to be defined in the ~~design statement~~ System Design Description required by 1.3.2.

8.1.3 The requirements for HP compressed air systems include the storage and distribution of compressed air with air pressures above 7 bar and are to be in accordance with the ~~design statement~~ System Design Description required by 1.3.2. Additional compressed air systems may be installed for specific purposes such as for diesel engine starting (typically 25–30 bar systems) which are also to comply with the requirements of this Section and ~~Pt 2, Ch 1,7~~ Ch 3, 12 as applicable.

8.2 Compressors

8.2.1 Two or more HP air compressors are to be provided of sufficient capacity to supply the total design demand of the system under defined requirements stated in the ~~design statement~~ System Design Description required by 1.3.2 with any one compressor out of action.

■ *Section 9*
Low pressure compressed air systems

9.1 General

9.1.2 Low pressure (LP) compressed air systems are to produce and distribute oil and moisture free cool compressed air throughout the ship to supply all systems and equipment where the air pressure requirements are 7 bar and below. The systems are to include air compressors, oil/water separators, filter/dryers, distribution lines and air receivers. For the purpose of ~~Naval Authority~~ maintenance and safety regulatory requirements, LP air systems may be defined as those where the air pressure requirements are 25–40 bar and below and this is to be defined in the ~~design statement~~ System Design Description required by 1.3.2.

9.1.3 The design of LP compressed air systems is to be capable of providing continuous flow for all demands of equipment and system consumers recognising continuous and intermittent users. This includes any portable equipment that may be part of the ship's equipment. Compressed air systems used for specific purposes such as for diesel engine or gas turbine starting are also to comply with the requirements of this Section and ~~Pt 2, Ch 1,7~~ Ch 3, 12 and Pt 2, Ch 2,6 as applicable.

■ *Section 10*
High pressure sea-water systems

10.1 General

10.1.3 The pumping and delivery capacities and pressures from the HPSW are to be sufficient to support damage control and fire-fighting policy, procedures and techniques, including pre-wet requirements that are to be declared in the ~~design statement~~ System Design Description required by 1.3.2.

10.2 Pump units

(*Part only shown*)
10.2.3 The total pumping capacity of the HPSW pumps with one pump out of action shall provide for the greatest of the following:

(c) The amount required for a major fire outside the machinery spaces using 100 m^3/hr boundary cooling for each fire. The minimum number of fires to be considered ~~are~~ is as follows:
  (i) Displacement at design draught of under 4,000 tonnes – one fire.
  (ii) Between 4,000 and 10,000 tonnes – two fires.
  (iii) Between 10,000 and 20,000 tonnes – three fires.
  (iv) Over 20,000 tonnes – four fires.

Reference is also to be made to the ~~design statement~~ System Design Description required by 1.3.2 where the number of fires to be considered may also reference amongst other items, the type of ship, number of personnel on board and number of fire zones.

10.2.6 HPSW pumps are to be arranged to operate continuously with automatic and switched means of starting of standby pumps on sea-water demand. Automatic starting of standby pumps may be achieved by sensing when the system pressure falls below a pre-set level. The continuous and minimum supply pressures in the HPSW distribution system are to be in accordance with the ~~design statement~~ System Design Description required by 1.3.2.

■ *Section 11*
Hydraulic power actuating systems

11.1 General

11.1.4 Hydraulic fluids are to be suitable for the intended purpose under all operating service conditions and conform to the ~~Naval Authority's~~ Owner's safety policy where applicable.

11.3 Pump units

11.3.1 Two or more hydraulic pumps are to be provided for each power actuating system. ~~the~~ The pumps are to be of sufficient capacity to supply the system under defined operational requirements stated in the ~~design statement~~ System Design Description required by 1.3.2 with any one pump out of action.

11.5 Cooling arrangements

11.5.1 Cooling arrangements for hydraulic fluids are to be provided where the operating temperature of the fluid may exceed the maximum design temperature limitations of the fluid or equipment in the system as defined in the ~~design statement~~ System Design Description required by 1.3.2.

11.8 Filling arrangements

~~*11.8.2* Provision is to be made against over-pressure in the filling pipelines. Any relief valve fitted for this purpose is to discharge to an overflow tank or other safe position and is to be sized to allow full flow of supply through the relief valve without over-pressurising the upstream pipework.~~

Volume 2, Part 8, Chapter 1

Steam Raising Plant and Associated Pressure Vessels

Effective Date 1 January 2015

■ *Section 1*
General requirements

1.13 Exhaust gas economiser/boiler arrangements

1.13.2 A ~~design statement~~ System Design Description demonstrating compliance with the requirements of 1.13.1 or alternative means of preventing the accumulation of soot or overheating, such as the use of exhaust gas bypass ducting with automatic flap valve arrangements and/or effective soot prevention and cleaning systems, is to be submitted for approval.

■ *Section 16*
Mountings and fittings for water tube boilers

16.2 Safety valves

16.2.3 Where the superheater forms an integral part of the boiler, the relieving capacity of the superheater safety valve(s), based on the reduced pressure at the superheater outlet, may be included as part of the total relieving capacity required for the boiler. As some ~~Naval Authorities~~ Naval Administrations may limit the proportion of the superheater safety valve relieving capacity which may be credited towards the total capacity for the boiler, ~~builders~~ Builders should give attention to any relevant requirements of the ~~Naval Authority~~ Naval Administration as specified.

Volume 2, Part 9

~~Control Engineering~~

Electrotechnical Systems

Chapter 1

~~Control Engineering Systems~~

General Requirements for the Design and Construction of Electrotecnical Systems

Effective Date 1 January 2015

■ *Section 1*
~~General engineering systems~~
General requirements

Existing paragraphs Pt 10, Ch 1, 1.1.3 *and* 1.1.4 *have been renumbered* Pt 9, Ch1, 1.1.2 *and* 1.1.3.

1.1 ~~General requirements~~ Scope

1.1.1 ~~This Chapter applies to systems~~ The requirements of this Part apply to the design and construction philosophy of electrotechnical systems and equipment providing electrical power, control, ~~alarm~~ alert or safety functions for the following:

- Main propulsion systems.
- Steering and manoeuvring systems.
- Electrical power systems.
- ~~Essential auxiliary~~ Mobility and ship type ancillary machinery systems.
- ~~Other engineering~~ Engineering systems necessary for the watertight and weathertight integrity of the ship and functioning of ship type category systems.

~~1.1.3~~ 1.1.2 Electrical services required to maintain the ship in a normal sea-going, operational and habitable condition are to be capable of being maintained without recourse to the emergency source of electrical power. The essential services for individual types of ships for sea-going, operational and habitable conditions on board are to be agreed by Lloyd's Register (hereinafter referred to as 'LR'). *See also* ~~1.6.1, 1.6.2 and 1.6.3~~ Pt 1, Ch 1, 3.1.5, 3.1.6 and 3.1.7.

~~1.1.4~~ 1.1.3 ~~Electrical~~ Electrotechnical services essential for safety are to be maintained under various emergency conditions.

Existing paragraph Pt 10, Ch 1, 1.1.5 *has been renumbered* Pt 9, Ch 1, 1.1.4.

Existing sub-Section Pt 10, Ch 1, 1.1 *has been renumbered* Pt 9, Ch 1, 1.2.

~~1.1~~ 1.2 Application

1.2.1 In addition to the requirements of this Chapter, Pt 1, Ch 1, Requirements for Classification of Engineering Systems and Ch 2, Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems shall be applied.

1.2.2 LR will be prepared to give consideration to special cases or to arrangements which are equivalent to the Rules where sufficient technical justification is provided.

Existing paragraphs Pt 10, Ch 1, 1.1.2, 1.1.6 *and* 1.1.7 *have been renumbered* Pt 9, Ch 1, 1.2.3, 1.2.4 *and* 1.2.5.

~~*1.1.2* Attention should also be given to any relevant requirements of the Naval Authority .~~

Existing paragraphs Pt 9, Ch 1, 1.3.4, 1.3.2 *and* 1.3.5 *have been renumbered* Pt 9, Ch 1, 1.2.6, 1.2.7 *and* 1.2.9.

~~1.3.4~~ 1.2.6 Assessment of performance parameters, such as accuracy, repeatability, etc., are to be in accordance with an acceptable specialised naval, ~~standard, national~~ National or ~~international standard~~ International Standard, e.g., IEC 60051, ~~*Direct acting indicating analogue electrical measuring instruments and their accessories.*~~ *Direct acting indicating analogue electrical measuring instruments and their accessories (all parts)*.

1.2.8 Equipment shall be selected with due regard to its required strength and capability. System design is to ensure that, under normal operation and foreseeable abnormal conditions, the equipment's strength and capability is not exceeded in such a way as may give rise to danger or may affect other essential services.

~~1.3.5~~ 1.2.9 Special consideration will be given to arrangements that comply with a relevant and acceptable ~~specialised naval~~, ~~national~~ National or ~~international standard~~ International Standard, such as IEC 60092-504~~,~~: ~~*Electrical Installation on Ships – Special Features: Control and Instrumentation*~~ *Electrical installation on ships – Part 504: Special features – Control and instrumentation*.

~~1.5~~ 1.3 Definitions

1.3.1 Reference is to be made to Pt 1, Ch 3, Sections 15 and 16 defining essential services, services considered necessary for minimum comfortable conditions of habitability and services considered necessary to maintain the ship in a normal seagoing, operational and habitable condition.

Existing paragraphs Pt 9, Ch 1, 1.5.1 *to* 1.5.3 *have been renumbered* Pt 9, Ch 1, 1.3.2 *to* 1.3.4.

Existing paragraphs Pt 10, Ch1, 1.6.4 *to* 1.6.16 *have been renumbered* Pt 9, 1.3.5 *to* 1.3.17.

~~1.6.4~~ 1.3.5 A 'high voltage' is a voltage exceeding 1000 V a.c. or 1500 V d.c. between conductors, *see also* ~~5.1.4~~ 4.1.3.

~~1.6.5~~ 1.3.6 A 'switchboard' is a switchgear and ~~control gear~~ controlgear assembly for the control of power generated by a source of electrical power and its distribution to electrical consumers.

~~1.6.6~~ 1.3.7 A 'section board' is a switchgear and ~~control gear~~ controlgear assembly for controlling the supply of electrical power from a switchboard and distributing it to other section boards, distribution boards or final sub-circuits.

Existing paragraphs Pt 10, Ch1, 1.6.7 *to* 1.6.11 *have been renumbered* Pt 9, Ch 1, 1.3.8 *to* 1.3.12.

~~1.6.12~~ 1.3.13 'Protected space' is a machinery space where a fixed water-based local application fire-fighting system is installed.

~~1.6.13~~ 1.3.14 'Protected areas' are areas within a protected space which are protected by a fixed water-based local application fire-fighting system.

~~1.6.14~~ 1.3.15 'Adjacent areas' are those, other than protected areas, exposed to direct spray or other areas where water may extend when a fixed water-based local application fire-fighting system is activated.

Existing paragraph Pt 10, Ch1, 1.6.15 *and* 1.6.16 *have been renumbered* Pt 9, Ch 1,1.3.16 *and* 1.3.17.

1.3.18 Alarm System: a system which will alert relevant personnel to faults, abnormal situations and other conditions requiring attention in the machinery and the safety and control systems.

1.3.19 Control System: a system which responds to input signals from the process and/or Operator and generates output signals causing the equipment under control to operate in the desired manner.

1.3.20 Failure: loss of the ability of a structure, system or element to function within acceptance criteria.

1.3.21 Fail safe: a system design such that, when a failure occurs, the system reverts to the least hazardous state.

1.3.22 A reasonably foreseeable abnormal condition is an event, incident or failure that:
- has happened and could happen again;
- is planned for (e.g. emergency actions cover such a situation, maintenance is undertaken to prevent it, etc.).

They should be identified by:
- using analysis processes that are capable of revealing abnormal conditions;
- employing a mix of personnel including competent safety/risk professionals and those with relevant domain knowledge and understanding to apply the processes;
- referencing relevant events and historic data; and documenting the results of the analysis.

1.3.23 Safety System: a designated system that:
- implements the required safety functions necessary to achieve or maintain a safe state for the equipment under control; and
- is intended to achieve, on its own or with other safety systems, the necessary safety needed for the required safety functions.

1.3.24 Safe State: state of equipment under control when safety is achieved. For some situations, a safe state only exists so long as the equipment under control is continuously controlled. Such continuous control may be for a short or indefinite period.

1.3.25 System: set of elements which interact according to a design, where an element of a system can be another system, called a sub-system, which may be a controlling system or a controlled system, and may include hardware, software and human interaction.

~~1.2~~ 1.4 Documentation required for design review

Existing paragraph Pt 10, Ch 1, 1.2.1 *has been renumbered* Pt 9, Ch 1, 1.4.1.

~~1.2.1~~ 1.4.1 The documentation in ~~1.2.2~~ 1.4.2 to ~~1.2.18~~ 1.4.26 is to be submitted for design review.

Existing paragraphs Pt 9, Ch 1,1.2.2 *and* 1.2.4 *have been renumbered* Pt 9, Ch 1, 1.4.2 *and* 1.4.3.

~~1.2.2~~ 1.4.2 ~~General. Description~~ A description of operation (with explanatory diagrams), schematic diagrams of circuits, and lists of monitored parameters with relevant setpoints:
- Controllable pitch propellers.
- Electric generating plant.
- Incinerators.
- Miscellaneous machinery or equipment (where control, alarm and safety systems are specified in other Sections of the Rules).
- Oil fuel transfer and storage systems.
- Propulsion machinery including essential auxiliaries.
- Steam raising plant (boilers and their ancillary equipment).
- Steering systems.
- Thermal fluid heaters.
- Thrust units.
- Valve position indicating systems.
- Waste-heat systems.
- Water jets for propulsion purposes.
- Fixed water-based local application fire-fighting systems, *see* ~~2.9~~ Ch 9, 5.2.

~~1.2.4~~ 1.4.3 ~~System operational concept~~. System Operational Concept. A description of how the control, alarm and safety systems for the main and auxiliary machinery and systems essential for the propulsion and ~~saftey~~ safety of the ship provide effective means for operation and control during all ship operational conditions.

Existing paragraph Pt 10, Ch 1, 1.2.2 *to* 1.2.17 *has been renumbered* Pt 9, Ch 1, 1.4.4 *to* 1.4.19.

~~1.2.3~~ 1.4.5 A ~~design statement~~ System Operational Concept of the electrical power system which details the capability and functionality under defined operating and emergency conditions is to be submitted, *see* Vol 1, Pt 1, Ch 2,2.2. The ~~design statement~~ System Operational Concept is to be agreed between the designers and Owners~~/Operators~~ and is to include:

(a) a description of operation of the main and emergency electrical power systems;

(b) an earthing philosophy document that defines the basic approach to be taken for earthing the electrical power systems and all electrical loads; and

(c) schedule of normal and emergency operating loads on the system estimated for the different operating conditions expected. The following details are to be provided to meet this requirement:
  (i) a description of the expected operating profiles (e.g., the number of generating sets connected when manoeuvring, at sea, etc.), including as required by Pt 2, Ch 1,2.1.1; and
  (ii) a schedule of the normal and emergency operating loads, which is to state the kilowatt rating of each load and a load factor between 0 and 1. The load factor is defined as the ratio of the calculated load to the maximum load possible over a declared duty cycle. As such, the load factor shall reflect: the duty cycle of the load; and the proportion of its maximum rating at which the load is expected to operate.

(d) the quality of power supplies required for each designated load, where this is required by ~~1.8.3~~ 2.1.3.

Existing paragraph Pt 10, Ch 1, 1.2.4 *has been renumbered* Pt 9, Ch 1, 1.4.6.

~~*1.2.5*~~ *1.4.7* Calculations of short circuit currents at main and emergency switchboards and section boards including those fed from transformers, details of circuit-breaker and fuse operating times, settings and discrimination curves showing compliance with ~~6.1~~ Ch 4, 4.1 and ~~11.6.2~~ Ch 3, 8.6.2.

~~*1.2.6*~~ *1.4.8* Where required by ~~8.1.1~~ Ch 4, 5.1.1, the hazards resulting from electric arcs within electrical equipment and their consequences for personnel are to be identified, and at least the following supporting evidence is to be submitted:

(a) system design;

(b) operating philosophies, e.g., manual or automatic control, local or remote operation;

(c) general arrangement plans for switchboards, section boards and distribution boards, *see also* ~~1.2.16~~ 1.4.18;

(d) general arrangement plans for the space in which the electrical equipment to be assessed is located, showing:
  - access to adjacent spaces;
  - the location of the electrical equipment;
  - ventilation arrangements for air conditioning and/or the extraction of smoke, gas and vapours resulting from electric arcs;
  - positions within the space in which the electrical equipment is located where personnel will be performing tasks, e.g., switching, equipment maintenance, instrument observation or cleaning, or where personnel could reasonably be expected to enter;

(e) calculations in accordance with ~~8.3~~ Ch 4, 5.3;

(f) system operating procedures; and

(g) details of defined additional safety measures to be taken during activities.

Existing paragraph Pt 10, Ch 1, 1.2.7 *has been renumbered* Pt 9, Ch 1, 1.4.9.

~~*1.2.8*~~ *1.4.10* A schedule of electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts giving details, as appropriate, of:

(a) type of equipment;
(b) type of protection, e.g., Ex ‘d’;
(c) apparatus group, e.g., IIB;
(d) temperature class, e.g., T3;
(e) enclosure ingress protection, e.g., IP55;
(f) certifying authority;
(g) certificate number;
(h) location of equipment.

Details may be included on arrangement drawings for the hazardous locations, in place of a separate schedule. Where uncertified equipment is permitted by ~~14.2 or 14.3~~ Ch 5, 4.2 or 4.3 or the Rules relevant to the specific type of ship, details of other documentation confirming (b) to (d) may be submitted in place of those listed under (f) and (g).

~~*1.2.9*~~ *1.4.11* Simplified circuit diagram of electrical propulsion system (where fitted) giving details of:

(a) ratings of electrical machines, transformers, batteries, dynamic braking assemblies and semiconductor converters;
(b) lubrication and cooling arrangements, where provided;
(c) insulation type, size and current loadings of cables;
(d) make, type and rating of circuit-breakers and fuses;
(e) instrumentation and protective devices;
(f) earth fault indication/protection;
(g) propulsion control systems and the procedures used to ensure that there is satisfactory control of the design in relation to the requirements of ~~16.4~~ Pt 1, Ch 4. 4.4; and
(h) harmonic analysis.

Existing paragraph Pt 10, Ch 1, 1.2.10 *has been renumbered* Pt 9, Ch 1, 1.4.12.

~~*1.2.11*~~ *1.4.13* Evidence of the suitability of electrical and electronic equipment for use in protected areas and adjacent areas, as required by ~~17.3.9 and 17.3.10~~ Ch 9, 5.2.15 and 5.2.16, including a schedule of electrical and electronic equipment located in protected areas and adjacent areas and general arrangement plans showing the coverage of the protected areas and adjacent areas.

~~*1.2.12*~~ *1.4.14* A test schedule ~~which~~ for both works testing, harbour trials and sea trials is to include the method of testing and the test facilities which are provided for the general emergency alarm system and the crew and embarked personnel address system.

Existing paragraph Pt 10, Ch 1, 1.2.13 *has been renumbered* Pt 9, Ch 1, 1.4.15.

~~*1.2.14*~~ *1.4.16* For battery installations, arrangement plans and calculations to show compliance with ~~12.5~~ Ch 2, 7.4.

~~*1.2.15*~~ *1.4.17* A schedule of batteries fitted for use for emergency and essential services, giving details of:

- type and manufacturer’s type designation;
- voltage and ampere-hour rating;
- location;
- equipment and/or system(s) served;
- maintenance/replacement cycle dates;
- date(s) of maintenance and/or replacement; and
- for replacement batteries in storage, the date of manufacture and shelf life, with accompanying battery

replacement procedure documentation to show compliance with ~~12.7~~ Ch 2, 7.7.

NOTE

The above includes all batteries fitted as part of an uninterruptible power system (UPS) used for any essential or emergency services.

~~1.2.16~~ 1.4.18 General arrangement plans showing the location of propulsion generators, motors, transformers, semiconductor converters, dynamic braking equipment, reactors and filters. The information supplied is also to include cable routes to show compliance with ~~11.8~~ Ch 3, 8.8, as applicable.

~~1.2.17~~ 1.4.19 Plans for all cables that pass through atria or equivalent spaces, and for vertical runs in trunks or other restricted spaces. The information supplied is to show compliance with ~~11.8.10~~ Ch 3, 8.8.10.

Existing paragraphs Pt 9, Ch 1, 1.2.5 *to* 1.2.13 *have been renumbered* Pt 9, Ch 1, 1.4.20 *to* 1.4.24.

~~1.2.5~~ 1.4.20 **Alarm systems**. Details of the overall alarm system linking the main control station, subsidiary control stations, the bridge area and accommodation including details of alerts to be presented by the user interface, with:

(a) an approach to alert category assignments which is in accordance with the IMO *Code on Alerts and Indicators, 2009*; and

(b) for alarms required by these Rules the intended ~~operator~~ Operator's response and the message are to be presented.

~~1.2.6~~ 1.4.21 **Programmable electronic systems**. (In addition to the documentation required by ~~1.2.2~~ Ch 1, 1.4.2).

(a) System requirements specification.

(b) Details of the hardware configuration in the form of a system block diagram, including input/output schedules.

(c) Details of power supply and data storage arrangements, *see* ~~2.10.9 and 2.13.6~~ Ch 8, 5.1.10 and Ch 8, 5.4.6.

(d) Hardware certification details, *see* ~~2.10.5 and 2.13.3~~ Ch 8, 5.1.6 and Ch 8, 5.4.3.

(e) Software quality plans, including applicable procedures, *see* ~~2.10.20~~ Ch 8, 5.1.21.

(f) Factory acceptance, integration, harbour and sea trial test schedules for hardware and software.

(g) System integration plan, *see* ~~2.14.2~~ Ch 8, 5.5.2.

(h) Risk Assessment (RA), *see* ~~2.14.5~~ Ch 8, 5.5.5 and Pt 1, Ch 2, 17.

~~1.2.7~~ 1.4.22 For wireless data communication equipment:

(a) details of manufacturer's installation and maintenance recommendations;

(b) network plan with arrangement and type of aerials and identification of location;

(c) specification of wireless communication system protocols and management functions, *see* ~~2.12.4~~ Ch 8, 5.3.4;

(d) details of radio frequency and power levels, including details of those permitted by the National Administration.

Existing paragraphs Part 9, Chapter 1, 1.2.3 *and* 1.2.13 *have been renumbered* Part 9, Chapter 1, 1.4.25 *and* 1.4.26.

~~1.2.3~~ 1.4.25 **Test schedules**. Test schedules for ~~both~~ works testing, factory acceptance tests, harbour testing and sea trials, which should include methods of testing and test facilities, *see* ~~7.5.1~~ Ch 11, 1.8.1.

~~1.2.12~~ 1.4.26 **Lifts**. For details of alarms and safeguards for lifts classed by ~~Lloyd's Register (hereinafter referred to 'LR')~~ LR, reference should be made to LR's *Code for Lifting Appliances in a Marine Environment*.

~~1.3~~ 1.5 Documentation required for supporting evidence

Existing paragraphs Pt 10, Ch 1, 1.3.1 *to* 1.3.6 *have been renumbered* Pt 9, Ch 1, 1.5.1 *to* 1.5.6.

~~1.3.1~~ 1.5.1 The documentation in ~~1.3.2~~ 1.5.2 to ~~1.3.5~~ 1.5.7 is to be submitted as supporting evidence.

~~1.3.2~~ 1.5.2 In order to establish compliance with ~~1.12.2 and 5.1.5 to 5.1.7~~ Ch 1, 2.2.7 and Ch 3, 4.1.5 to 4.1.7, a general arrangement plan of the ship showing the location of major items of electrical equipment, for example:

- main and emergency generators;
- switchboards;
- section boards and distribution boards supplying essential and emergency services;
- emergency batteries;
- motors for emergency services; and
- cable routes between these items of equipment.

~~1.3.3~~ 1.5.3 Arrangement plans of main and emergency switchboards and section boards, and documentation that demonstrates that creepage and clearance distances are in accordance with ~~7.5~~ Ch 3, 5.7. The form factor of internal separation of low voltage switchgear and ~~control gear~~ controlgear assemblies is to be in accordance with IEC 61439-2, *Low-voltage switchgear and ~~control gear~~ controlgear assemblies – Part 2: Power switchgear and ~~control gear~~ controlgear assemblies*, or an alternative acceptable and relevant national Standard. The form factor is to be stated, and the arrangement plans are to show how the form factor has been achieved.

Existing paragraph Pt 10, Ch 1, 1.3.4 *has been renumbered* Pt 9, Ch 1, 1.5.4.

~~1.3.5~~ 1.5.5 In order to establish compliance with the requirements of ~~1.7.3~~ Ch 1, 2.2.3, when requested, evidence is to be submitted to demonstrate the suitability of electrical equipment for its intended purpose in the conditions in which it is expected to operate.

~~1.3.6~~ 1.5.6 Where deviation from the specific requirements of these Rules is required, details of the arrangements with documented justification and/or analysis are to be submitted, *see* ~~1.1.6~~ Ch 1, 1.2.4.

Existing paragraph Pt 9, Ch1, 1.2.11 *has been renumbered* Pt 9, Ch1, 1.5.7.

~~1.2.11~~ 1.5.7 **Cables**. For details of instrumentation and control requirements~~, see Pt 10, Ch 1,11~~.

~~1.4~~ 1.6 Surveys

Existing paragraphs Pt 10, Ch 1, 1.4.1 *to* 1.4.3 *have been renumbered* Pt 9, Ch 1, 1.6.1 *and* 1.6.3.

~~1.4.3~~ 1.6.3 For electric propulsion systems, in addition to the equipment listed in ~~1.4.2~~ 1.6.2, the following equipment is to be surveyed by the Surveyors during manufacture and testing:

- cables, *see* ~~11.1.4~~ Ch 3, 8.1.4;
- exciters;
- filters;
- reactors;
- dynamic braking assemblies;
- pre-magnetisation transformers; and
- slip ring assemblies.

Existing paragraph Pt 9, Ch 1, 1.3.1 *has been renumbered* Pt 9, Ch 1, 1.6.4.

~~1.3.1~~ 1.6.4 ~~Major units of equipment~~ Equipment associated with control, alarm and safety functions for systems listed in 1.1.1 are to be surveyed at the manufacturers' works in accordance with the approved test schedule (*see* ~~1.2.3~~ Ch 1, 1.4.25), and the inspection and testing are to be to the Surveyor's satisfaction, *see* ~~1.2.2~~ Ch 1, 1.4.2.

Existing paragraph Pt 10, 1.4.4 *has been renumbered* Pt 9, Ch 1, 1.6.5.

~~1.4.4~~ 1.6.5 All other electrical equipment, not specifically referenced in ~~1.4.2~~ 1.6.2 and ~~1.4.3~~ 1.6.4, intended for use for essential or emergency services is to be supplied with a manufacturer's works test certificate showing compliance with the constructional standard(s) as referenced by the relevant requirements of the Chapter.

~~1.4~~ 1.7 Alterations and additions

Existing paragraphs Pt 10, Ch 1, 1.5.1, 1.5.4 *to* 1.5.6 *have been renumbered* Pt 9, Ch 1, 1.7.2, 1.7.6 *to* 1.7.8.

Existing paragraphs Pt 9, Ch 1, 1.4.1 *and* 1.4.2 *have been renumbered* Pt 9, Ch 1, 1.7.1 *and* 1.7.3.

~~1.4.2~~ 1.7.3 Details of proposed software modifications are to be submitted for consideration. Modifications are to be undertaken in accordance with defined modification processes which are part of the supplier's or system integrator's quality management system. The quality management system is to be acceptable to LR, *see* Vol 2, Pt 1, Ch 1, Section 8. The following documentation is to be submitted:

(a) Project-specific software modification plan.
(b) An impact analysis which identifies the effect(s) of the proposed modification. The results of the analysis are to be used to inform the extent of verification and validation that is to be applied. This analysis is to consider both the local impact and, where applicable, the system level impact of the modification.
(c) Configuration management records that satisfy the requirements of ISO 10007, to demonstrate the traceability of the proposed modification.
(d) Factory acceptance, integration and sea trial test schedules as determined by the impact analysis in (b).
(e) Updated documentation as detailed in 1.2.6.

1.7.4 Verification and validation activities are to demonstrate that the modified functionality performs as expected and that the modification has not unintentionally modified functionality outside the scope of the modification.

Existing paragraph Pt 9, Ch 1, 1.4.3 *has been renumbered* Pt 9, Ch 1, 1.7.5.

~~1.5.4~~ 1.7.6 Proposed modifications to the electrical protection systems are to be developed in accordance with ~~6.1.4~~ Ch 4, 4.1.4 and plans submitted are also to address the updating of the approved version of the details required by ~~1.2.4 and 1.2.5~~ Ch 1, 1.4.6 and 1.4.7.

~~1.5.5~~ 1.7.7 When it is proposed to replace permanently installed secondary valve-regulated sealed batteries with vented batteries, details are to be submitted for consideration to ensure continued safety in the presence of the products of electrolysis and evaporation being allowed to escape freely from the cells to the atmosphere. These details are to demonstrate that there will be adequate ventilation in accordance with ~~12.5.9~~ Ch 2, 7.5.9 and that the location and installation requirements of ~~12.3 and 12.4~~ Ch 2, 7.3 and 7.4 are complied with.

~~1.5.6~~ 1.7.8 Where it is intended to replace an existing incandescent lamp type navigation light with a light emitting diode type navigation light, details are to be submitted for consideration that demonstrate compliance with ~~15.5~~ Ch 6, 4.7. Light emitting diode type navigation lights failure detection arrangements are additionally to satisfy the requirements of ~~15.5.5 and 15.5.6~~ Ch 6, 4.7.5 and 4.7.6.

■ *Section 2*
System level requirements

~~1.8~~ 2.1 Quality of power supplies (QPS)

Existing paragraphs Pt 10, Ch 1, 1.8.1 *to* 1.8.6 *have been renumbered* Pt 9, Ch 1, 2.1.1 *to* 2.1.6.

~~1.8.5~~ 2.1.5 Where the electrical class notation **ELS** is to be assigned, *see* ~~1.9~~ Section 3.

Existing paragraph Pt 10, Ch 1, 1.8.6 *has been renumbered* Pt 9, Ch 1, 2.1.6.

~~1.7~~ 2.2 Design ~~and construction~~, construction and location

Existing paragraphs Pt 10, Ch 1, 1.7.1 *to* 1.7.4 *have been renumbered* Pt 9, Ch 1, 2.2.1 *to 2.2.4.*

~~1.7.2~~ 2.2.2 The design and installation of ~~other~~ all equipment is to be such that risk of fire due to its failure is minimised. It is, as a minimum, to comply with a National or International Standard revised where necessary for ambient conditions.

~~*1.7.3*~~ *2.2.3* Electrical equipment is to be suitable for its intended purpose in all conditions in which it is expected to operate. Equipment is to be designed and constructed in accordance with ~~appropriate International Standards or, in the absence of such, relevant National Standards~~ agreed specified standards ~~or naval publications acceptable to LR and the Navy or Naval Authority~~. The design and construction is to take account of both functional and environmental requirements. For details of marine environmental conditions, reference should be made to Annex B of IEC 60092: *Electrical installations in ships - Part 101: Definitions and general requirements*.

Existing paragraph Pt 10, Ch 1, 1.7.4 *has been renumbered* Pt 9, Ch 1, 2.2.7.

Existing paragraphs Pt 9, Ch 1, 1.3.3 *to* 1.3.5 *have been renumbered* Pt 9, Ch 1, 2.2.5 *to* 2.2.7.

~~*1.3.5*~~ *2.2.7* Special consideration will be given to arrangements that comply with a relevant and acceptable specialised ~~naval~~ Naval, ~~national~~ National or ~~international~~ International ~~standard~~ Standard, such as IEC 60092-504, *Electrical Installation on Ships – Special Features: Control and Instrumentation*.

Existing paragraph Pt 10, Ch 1, 1.12.1 *to* 1.12.14 *has been renumbered* Pt 9, Ch 1, 2.2.8 *to* 2.2.21.

~~*1.12.1*~~ *2.2.8* All electrical equipment is be constructed or selected and installed such that:

(a) live parts cannot be inadvertently touched, unless they are supplies at the safety voltage specified in ~~1.13.2(h)~~ 2.4.2 (h);

(b) it does not cause injury when handled or touched in the normal manner; and

(c) it is unaffected by any water, steam or oil and oil vapour to which it is likely to be exposed.

Where not exposed to direct liquid spray, electrical equipment having, as a minimum, the degrees of protection as specified in IEC 60092-201 for the relevant location will satisfy these requirements. Where the equipment may be exposed to direct liquid spray, the degree of protection is not to be less than IPX4. Where the equipment may be exposed to possible liquid immersion, the degree of protection is not to be less than IPX7.

Existing paragraph Pt 10, Ch 1, 1.12.2 *has been renumbered* Pt 9, Ch 1, 2.2.9.

~~*1.12.3*~~ *2.2.10* Electrical equipment, as far as is practicable, is to be located:

(a) such that it is accessible for the purpose of maintenance and survey;

(b) clear of flammable material;

(c) in spaces adequately ventilated to remove the waste heat liberated by the equipment under full load conditions, at the ambient conditions specified in ~~1.10~~ 2.3;

(d) where flammable gases cannot accumulate. If this is not practicable, electrical equipment is to be of the appropriate ‘safe type’, *see* ~~Section 14~~ Ch 5, 4;

(e) where it is not exposed to the risk of mechanical injury or damage from water, steam or oil.

~~*1.12.4*~~ *2.2.11* Equipment design and the choice of materials are to reduce the likelihood of fire, ensuring that:

(a) where the electrical energised part can cause ignition and fire, it is contained within the bounds of the enclosure of the electrotechnical product;

(b) the design, material(s) and construction of the enclosure minimises, as far as is practicable, any internal ignition causing ignition of adjacent materials; and

(c) where surfaces of the electrotechnical products can be exposed to external fire, they do not, as far as practicable, contribute to the fire growth.

NOTE
Compliance with IEC 60695~~;~~: *Fire hazard testing (all parts)*, or an alternative and acceptable standard, will satisfy this requirement, *see also* ~~1.15.4~~ Ch 3, 8.10.7.

Existing paragraph Pt 10, Ch 1, 1.12.5 *has been renumbered* Pt 9, Ch 1, 2.2.12.

~~*1.12.6*~~ *2.2.13* The minimum creepage and clearance distances provided for electrical connections, terminals and similar bare live parts are to be in accordance with a relevant International or National Standard for the equipment or apparatus concerned. In cases where the rated voltage is outside that given in the Standard or where no Standard is available, the minimum creepage and clearance distances provided are to be in accordance with ~~7.5~~ Ch 3, 5.7. Details of alternative proposals including supporting design rationale and demonstration may be submitted for consideration.

~~*1.12.7*~~ *2.2.14* Studs, screw-type of spring-type clamp terminations, satisfactory for the normal operating currents and voltages, are to be provided in electrical equipment for the connection of external cable, or bus-bar conductors, as appropriate, *see also* ~~11.15~~ Ch 3, 8.15. There is to be adequate space and access for the terminations.

Existing paragraphs Pt 10, Ch 1, 1.12.8 to 1.12.13 *have been renumbered* Pt 9, Ch 1, 2.2.15 *to* 2.2.20.

~~*1.12.14*~~ *2.2.21* Where electrical power is used for propulsion, the equipment is to be so arranged that it will operate satisfactorily in the event of partial flooding by bilge water above the tank top up to the bottom floor plate level under the normal angles of inclination given in ~~1.10~~ Ch 1, 2.3 for essential electrical equipment, *see* Pt 7, Ch 2,4. This requirement excludes military aspects that are required to be defined by Pt 1, Ch 2,4.9.

Existing paragraphs Pt 10, Ch1, 1.15.3 *and* 1.15.4 *have been renumbered* Pt 9, Ch 1, 2.2.22 *and* 2.2.23.

~~*1.15.3*~~ *2.2.22* Cables for emergency alarms and their power sources are to be in accordance with ~~1.18~~ Ch 1, 2.5.

~~*1.15.4*~~ *2.2.23* Electrical equipment and cables for emergency alarms are to be so arranged that the loss of alarms in any one area due to localised fire, collision, flooding or similar damage is minimised, *see* ~~1.16 to 1.18~~ Ch 1, 2.8 and Ch 1, 2.5.

~~1.10~~ 2.3 Ambient reference and operating conditions

2.3.1 Reference is to be made to Vol 2, Pt 1, Ch 2, 4.4 and 4.5 for the requirements concerning: Ambient reference conditions and Ambient operating conditions, with regards to the rating of essential electrical equipment for classification of restricted and unrestricted service conditions, and satisfactory operating conditions of main and essential auxiliary machinery.

Existing paragraphs Pt 10, Ch 1, 1.10.4 *to* 1.10.6 *have been renumbered* Pt 9, Ch1, 2.3.2 *to* 2.3.4.

~~*1.10.4*~~ *2.3.2* Where electrical equipment is installed within environmentally controlled spaces, the ambient temperature for which the equipment is suitable for operation at its rated capacity may be reduced to a value not less than 35°C provided:

- the equipment is not for use for emergency services and is located outside of machinery space(s);
- temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit(s) is (are) capable of satisfactorily maintaining the design temperature;
- the equipment is able to be initially set to work safely within a 45°C ambient temperature until such a time that the lesser ambient temperature may be achieved; the cooling equipment is to be rated for a 45°C ambient temperature;
- alarms are provided, at a continually attended control station, to indicate any malfunction of the cooling units. ~~*See also* Pt 9, Ch 1, 1.3.3~~.

~~*1.10.5*~~ *2.3.3* Where equipment is to comply with ~~1.10.4~~ 2.3.2, it is to be ensured that electrical cables for their entire length are adequately rated for the maximum ambient temperature to which they are exposed along their length.

~~*1.10.6*~~ *2.3.4* Equipment used for cooling and maintaining the lesser ambient temperature in accordance with ~~1.10.4~~ 2.3.2 are considered essential services and are to satisfy the requirements of ~~5.2~~ Ch 3, 4.2.1.

~~1.13 Earthing of non-current carrying parts~~

2.4 Earthing and bonding

Existing paragraphs Vol 2, Pt 10, Ch 1, 1.13.1 *to* 1.13.10 *have been renumbered* Vol 2, Pt 9, Ch 1, 2.4.1 *to* 2.4.10.

~~*1.13.1*~~ *2.4.1* Except where exempted by ~~1.13.2~~ 2.4.2, all non-current carrying exposed metal parts of electrical equipment and cables are to be earthed for personnel protection against electric shock. Bonding is to give a substantially equal potential and a sufficiently low earth fault loop impedance to ensure correct operation of protective devices.

~~*1.13.2*~~ *2.4.2* The following parts may be exempted from the requirements of ~~1.13.1~~ 2.4.1:

(a) lamp-caps, where suitably shrouded;
(b) shades, reflectors and guards supported on lampholders or light fittings constructed of, or shrouded in, non-conducting material;
(c) metal parts on, or screws in or through, non-conducting materials, which are separated by such material from current-carrying parts and from earthed non-current carrying parts in such a way that in normal use they cannot become live or come into contact with earthed parts;
(d) apparatus which is constructed in accordance with the principle of double insulation;
(e) bearing housings which are insulated in order to prevent circulation of current in the bearings;
(f) clips for fluorescent lamps;
(g) cable clips and short lengths of pipes for cable protection;
(h) apparatus supplied at a safety voltage not exceeding 55 V direct current or 55 V, root mean square, between conductors, or between any conductor and earth in a circuit isolated from the supply. Autotransformers are not to be used for the purpose of achieving the alternating current voltage;
(j) apparatus or parts of apparatus which although not shrouded in insulating material is nevertheless otherwise so guarded that it cannot be touched and cannot come in contact with exposed metal.

~~*1.13.4*~~ *2.4.4* Armouring, braiding and other metal coverings are to be effectively earthed. Where the armouring, braiding and other metal coverings are earthed at one end only, they are to be adequately protected and insulated at the unearthed end with the insulation being suitable for the maximum voltage that may be induced. *See* ~~14.9.2~~ Ch 5, 4.9.2 for earthing of cables in hazardous zones or spaces.

~~*1.13.8*~~ *2.4.8* The nominal cross-sectional areas of copper earthing conductors for armouring, braiding and other metal coverings of cables are, in general, to be equal to the equivalent cross-section of the armouring, braiding and other metal coverings with a minimum of 1,5 mm^2.

Existing paragraphs Pt 10, Ch 1, 1.13.9 *and* 1.13.10 *have been renumbered* Pt 9, Ch 1, 2.4.9 *and* 2.4.10.

Existing paragraphs Vol 2, Pt 10, Ch 1, 1.14.1 *and* 1.14.2 *have been renumbered* Vol 2, Pt 9, Ch 1, 2.4.11 *and* 2.4.12.

~~*1.14.2*~~ *2.4.12* Where bonding straps are required for the control of static electricity, they are to be robust, that is, having a cross-sectional area of at least 10 mm^2, and are to comply with ~~1.13.6~~ 2.4.6 and ~~1.13.10~~ 2.4.10.

~~1.18~~ 2.5 Operation under fire conditions

Existing paragraphs Pt 10, Ch 1, 1.18.1 *to* 1.18.4 *have been renumbered* Pt 9, Ch 1, 2.5.1 *to* 2.5.4.

~~1.18.1~~ 2.5.1 As a minimum, the following emergency services and their emergency power supplies are required to be capable of being operated under fire conditions:

- Emergency fire pump.
- Control and power systems to power-operated fire doors and status indication for all fire doors.
- Control and power systems to power-operated watertight doors and their status indication.
- Emergency lighting.
- Fire and general emergency alarms.
- Fire detection systems.
- Fire-extinguishing systems and fire-extinguishing media release alarms.
- Fire safety stops, *see also* ~~17.6~~ Ch 5, 4.9.2.
- Low location lighting, *see also* ~~18.4.3~~ Ch 9, 4.8.3.
- Crew and embarked personnel address systems.

~~1.18.2~~ 2.5.2 Where cables for the emergency services listed in ~~1.18.1~~ 2.5.1 pass through high fire risk areas, main vertical or horizontal fire zones other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the emergency service in any other area or zone. This may be achieved either by:

- cables being of a fire-resistant type complying with ~~11.5.3~~ Ch 3, 8.5.3, and at least extending from the main control/monitoring panel to the nearest local distribution panel serving the relevant area or zone; or
- there being at least two loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.

Areas of high fire risk include:

(a) Machinery spaces including diesel generator compartments and gas turbine compartments but excluding those spaces which do not contain machinery having a pressure lubrication system and where the storage of combustibles is prohibited.
(b) Galleys.
(c) Compartments with tanks containing flammable liquids with a flash point lower than 60°C or with a temperature above 32°C.
(d) Compartments containing liquid oxygen.
(e) Fuel, petrol, oil or lubricant pump spaces.
(f) Magazines for munitions and armaments.

~~1.18.3~~ 2.5.3 Where the cables for the power supplies for the emergency services listed in ~~1.18.1~~ 2.5.1 pass through high fire risk areas, main vertical or horizontal fire zones other than those which they serve, they are to be of a fire-resistant type complying with ~~11.5.3~~ Ch 3, 8.5.3, extending at least to the local distribution panel serving the relevant area or zone.

~~1.18.4~~ 2.5.4 Fire-resistant electrical cables for the emergency services listed in ~~1.18.1~~ 2.5.1, including their power supplies, are to be run as directly as is practicable, having regard to any special installation requirements, for example those concerning minimum bend radii.

~~1.17~~ 2.6 Operation under flooding conditions

Existing paragraphs Pt 10, Ch 1, 1.17.1 *and* 1.17.2 *have been renumbered* Pt 9, Ch 1, 2.6.1 *and* 2.6.2.

~~1.20~~ 2.7 Electrical supplies to systems fulfilling military requirement

Existing paragraph Pt 10, Ch 1, 1.20.1 *to* 1.20.4 *have been renumbered* Pt 9, Ch 1, 2.7.1 *to* 2.7.4.

~~1.20.2~~ 2.7.2 Dedicated electrical supply arrangements to military systems are to be in accordance with recognised ~~international/national~~ International/National/specialised naval Standards.

Existing paragraphs Pt 10, Ch 1, 1.20.3 *and* 1.20.4 *have been renumbered* Pt 9, Ch 1, 2.7.3 *and* 2.7.4.

~~1.16~~ 2.8 Labels, signs and notices

Existing paragraph Pt 10, Ch 1, 1.16.1 *to* 1.16.4 *have been renumbered* Pt 9, Ch 1, 2.8.1 *to* 2.8.4.

~~1.16.2~~ 2.8.2 Labels, signs and notices are to be easy to read under the expected operating conditions. Character height in accordance with Table ~~1.1.1~~ 1.2.1 will be considered to satisfy this requirement.

Existing paragraph Pt 10, Ch 1, 1.16.3 *has been renumbered* Pt 9, Ch 1, 2.8.3.

(*Part only shown*)

Table ~~1.1.1~~ 1.2.1 Character height and viewing distance

Existing paragraph Pt 10, Ch 1, 1.16.4 *has been renumbered* Pt 9, Ch 1, 2.8.4.

Section 3
~~Ergonomics of control stations~~ Quality of power supplies – ELS notation

Existing paragraphs Pt 10, Ch 1, 1.9.1 *and* 1.9.2 *to* 1.9.7 *have been renumbered* Pt 9, Ch 1, 3.1.1 *and* 3.2.1 *to* 3.2.6.

~~1.9~~ 3.1 ~~Quality of power supplies – ELS notation~~ General

~~1.9.1~~ 3.1.1 Where electrical power for the designated loads in the ~~design statement~~ System Design Description of ~~1.2.3~~ Ch 1, 1.4.5 is provided in accordance with the applicable provisions of a relevant and acceptable naval standard, such as STANAG 1008, the class notation ELS may be assigned.

3.2 General requirements

~~1.9.2~~ 3.2.1 The electrical system is to be stable in all operating profiles defined in accordance with the ~~design statement~~ System Operational Concept.

~~1.9.3~~ 3.2.2 The quality of the power supplies for the loads listed in the ~~design statement~~ System Operational Concept ~~are~~ is to comply with the standard, in place of the limits specified by ~~1.8.2 and 1.8.3~~ 2.1.2 and 2.1.3. This level of quality is to be present at the point where the load is connected to the electrical power system.

~~1.9.4~~ 3.2.3 Where the main generation and the distribution power supplies are also required to comply with the standard, the main generation and distribution system is to be of an insulated type in compliance with ~~5.4~~ Ch 3, 4.4. *See also* ~~5.5.7~~ Ch 3, 4.5.7.

~~1.9.5~~ 3.2.4 A systematic procedure incorporating verification and validation methods is to be used to ensure successful implementation of the defined standard. A quality plan is to be submitted that describes this procedure along with the results of the design validation providing:

- details of any power system analysis software and the input data used;
- a transient stability analysis, unless the generator and load characteristics indicated by ~~9.4~~ Ch 2,6.4 are shown to be representative of the system under consideration;
- a harmonic distortion analysis, if the sum of loads that distort the current waveform is greater than 1per cent of the short-circuit power of the generating capacity.

~~1.9.6~~ 3.2.5 Where a transient stability analysis demonstrates that the defined standard requirements can be satisfied by generator control requirements different from those specified by ~~9.4~~ Ch 2,6.4 , these may be accepted as equivalent to the Rules.

~~1.9.7~~ 3.2.6 Unless it can be satisfactorily shown by the design verification and validation process that the requirements of the defined standard can be met, then measurements are to be taken as specified in ~~21.2.5~~ Ch 11, 1.2.8.

■ *Section 4*
Unattended machinery space(s) – UMS notation

4.1 General

~~*4.1.2* Where a first stage alarm together with a second stage alarm and automatic shut-down of machinery are required in the relevant Table of this Section, the sensors and circuits utilised for the second stage alarm and automatic shut-down are to be independent of those required by the first stage alarm.~~

4.2 Alarm systems for machinery

4.2.1 An alarm system which will provide warning of faults in the machinery is to be installed. The system is to satisfy the requirements of ~~2.3~~ Ch 7, 4.3.

4.2.3 The engineers' alarm required by ~~2.2.3~~ Ch 7, 4.2.3 is to be activated automatically in the event that a machinery alarm has not been acknowledged in the space within a predetermined time.

4.2.5 Group alarms may be arranged on the bridge to indicate machinery faults, but alarms associated with faults requiring speed or power reduction or the automatic ~~shut-down~~ shutdown of propulsion machinery are to be identified by separate group alarms or by individual alarms.

4.3 Bridge control for propulsion machinery

4.3.1 A bridge control system for the propulsion machinery is to be fitted. The system is to satisfy the requirements of ~~2.6~~ Ch 7, 4.6.

4.4 Control stations for machinery

4.4.1 A control station(s) is to be provided in the space and on the bridge which satisfies the requirements of ~~2.2~~ Ch 7, 4.2.

4.5 Fire detection alarm system

4.5.1 An automatic fire detection system is to be fitted in the space together with an audible and visual alarm system. The system is to satisfy the requirements of ~~2.8~~ Ch 9, 4.1.

4.6 Bilge level detection

4.6.1 An alarm system is to be provided to warn when liquid in machinery space bilges has reached a predetermined level, and is to comply with ~~2.3~~ Ch 7, 4.3. This level is to be sufficiently low to prevent liquid from overflowing from the bilges onto the tank top. The number and location of detectors are to be such that accumulation of liquids will be detected at all angles of heel and trim.

4.7 Supply of electric power, general

4.7.1 For naval ships operating with one generator set in service, arrangements are to be such that a standby generator will automatically start and connect to the switchboard in as short a time as practicable, but in any case within 45 seconds, on loss of the service generator. For naval ships operating with two or more generator sets in service, arrangements are to be such that on loss of one generator the remaining one(s) are to be adequate for continuity of essential services. For the detailed requirements of these arrangements, *see* ~~Pt 10, Ch 1,2.2~~ Ch 2,4.2.

Table 1.4.1 Electric system: ~~Alarms~~ alarms and safeguards

■ *Section 5*
Machinery operated from a centralised control station – CCS notation

5.1 General requirements

5.1.1 Where it is proposed to install control, alarm and safety systems to the equipment listed in 4.1.1 the applicable features contained in ~~2.2 to 2.13~~ Ch 7, Section 4 and Ch 8, Sections 4 and 5 are to be incorporated in the system design.

5.1.3 The controls, alarms and safeguards required by the appropriate Chapters and by 4.6 together with a fire detection system satisfying the requirements of ~~2.8~~ Ch 9, 4.1 are to be provided.

5.2 Centralised control station for machinery

5.2.1 A centralised control station is to be provided at some suitable location, which satisfies the requirements of 5.2.2 to 5.2.7 and the ergonomics requirements of Pt 10, Ch.1.

5.2.2 A system of alarm displays and controls is to be provided which readily ensures identification of faults in the machinery and satisfactory supervision of related equipment. The alarm and control systems are to satisfy the requirements of ~~2.3 and 2.5~~ Ch 7, 4.3 and 4.5, as applicable.

■ *Section 6*
Integrated computer control – ICC notation

6.1 General

6.1.1 Integrated Computer Control class notation **ICC** may be assigned where an integrated computer system in compliance with ~~5.1~~ 6.1 to ~~5.3~~ 6.3 provides fault tolerant control and monitoring functions for one or more of the following services:

(a) Propulsion.
(b) Electrical generation and distribution (power management systems).
(c) Ballast.

6.1.2 A Risk Assessment (RA) is to be carried out in accordance with Pt 1, Ch 2, 17 and the report and worksheets submitted for consideration, *see also* ~~2.14.5~~ Ch 8, 5.5.5. The RA is to demonstrate that control and monitoring functions required by 6.2 will remain available at each operator station in the event of a single fault of the integrated computer control system, including input error, without adverse effect on the service(s).

6.2 General requirements

6.2.1 The integrated computer control system is to comply with the programmable electronic system requirements of ~~2.10 to 2.14~~ Ch 8, Section 5 and the control and monitoring requirements of the Rules applicable to particular equipment, machinery or systems.

6.2.2 Alarm displays are to be provided, in compliance with the requirements of ~~2.3~~ Ch 8, 4.3, which ensure ready identification of faults in the equipment under control.

6.2.3 Alarm and indication functions required by ~~2.4~~ Ch 8, 4.4 are to be provided by the integrated computer control system in response to the activation of any safety function for associated machinery. Systems providing the safety functions are in general to be independent of the integrated computer system. *See also* ~~2.13.8~~ Ch 8, 5.4.8.

6.2.4 Controls are to be provided, in compliance with ~~2.5~~ Ch 8, 4.5, to ensure the safe and effective operation of equipment and response to faults, e.g., stopping, starting, adjustment of parameters, etc. Indication of operational status and other such parameters, necessary to satisfy this requirement, is to be provided for all equipment under control by the integrated computer control system.

6.3 Operator stations

6.3.1 Each operator station allowing control of equipment is to be provided with a minimum of two multi-function display and control units and is to comply with the ergonomics requirements of Pt 10, Ch 1. The number of units is to be sufficient to allow simultaneous access to control and monitoring functions required by 6.2.2 to 6.2.4. *See also* ~~2.10.20~~ Ch 10, 5.1.21.

6.3.3 Where the integrated computer control system is arranged such that control and monitoring functions may be accessed at more than one operator station, the selected mode of operation of each station (e.g., in control, standby, etc.) is to be clearly indicated. *See also* ~~2.2~~ Ch 7, 4.2.

Volume 2, Part 9, Chapter ~~1~~ 2

~~Control Engineering Systems~~

Electrotechnical Systems

Volume 2, Part 9, Chapter 2

Electrical Power Generator and Energy Storage

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy of electrical power generation and storage systems, including battery installations and generators driven by internal combustion engines, steam turbines and gas turbines.

This Chapter details the requirements for sub-systems and equipment within the boundary of electrical power system and is applicable for main and emergency auxiliary power generation as well as integrated electrical power generation and propulsion systems.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77, NATO Naval Ship Code*, Chapter IV, Regulation 9.

■ *Section 1*

Functional requirements

1.1 Functional requirements

1.1.1 Provide sufficient electrical power to supply the required services and habitability requirements during all operational conditions without recourse to the emergency electrical supply.

1.1.2 Provide sufficient electrical power to services essential for safety during foreseeable abnormal and emergency conditions.

1.1.3 Provide transitional power supplies where no interruption of the electrical supply to services essential for safety is required.

1.1.4 Provide sufficient stored electrical energy to supply the services essential for safety during foreseeable abnormal and emergency conditions.

1.1.5 Provide sufficient electrical power for the purpose of emergency radio communications independent of the main and emergency (where provided) sources of electrical power.

■ *Section 2*

Performance requirements

2.1 Performance requirements

2.1.1 Arrangements shall be provided for the supply of electrical power sufficient to supply the required services and habitability during:

(a) All operational conditions;
(b) Irrespective of the direction of the propulsion shaft rotation;
(c) Without any recourse to the emergency source of electrical power.

2.1.2 System design intent shall provide for sufficient electrical power to supply essential services and habitable conditions in the event of loss or unavailability of any one generating set.

2.1.3 Suitable protection measures shall be provided in accordance with Chapter 4.

2.1.4 No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as to give rise to danger or affect essential safety functions.

2.1.5 Where applicable, facilities to safely connect shore side electrical power shall be provided.

2.1.6 Means shall be provided to ensure that the propulsion machinery can be brought into operation following the loss of all means of electrical power generation using only sources of stored electrical power and without external aid.

2.1.7 Arrangements for the safe installation, use and maintenance of energy storage devices shall be provided.

2.1.8 In the event of failure of the main source of electrical power, a means to supply sufficient electricity to ensure the operation of all services essential for safety in an emergency shall be provided within a specified time and for a duration accepted by the Naval Administration.

2.1.9 Where no emergency generator is fitted, following the loss of a space due to fire or flooding, or loss of adjacent compartments, sufficient electrical power to supply services essential for safety in an emergency is to be available.

2.1.10 For essential safety functions for which an interruption to supply is unacceptable, transitional electrical supplies with sufficient capacity and duration accepted by the Naval Administration shall be provided.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 9 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section ~~2~~ 4*
Main source of electrical power

Existing Pt 10, Ch 1, Section 2 *has been renumbered* Pt 9, Ch 2, Section 4*.*

~~2.1~~ 4.1 General

Existing paragraph Pt 10, Ch 1, 2.1.1 *has been renumbered* Pt 9, Ch 2, 4.1.1.

~~2.2~~ 4.2 Number and rating of generators and converting equipment

Existing paragraph Pt 10, Ch 1, 4.2.1 *has been renumbered* Pt 9, Ch 2, 4.2.1.

~~2.2.1~~ 4.2.1 Under sea-going conditions, the number and rating of service generating sets and converting sets, such as transformers and semi-conductor converters, when any one generating set or converting set is out of action, are:

(a) to be sufficient to ensure the operation of electrical services for essential equipment and habitable conditions. *See* ~~16.3.5~~ Pt 4, Ch 5, 4.3.5 for electric propulsion systems;

(b) to have sufficient reserve capacity to permit the starting of the largest motor without causing any motor to stall or any device to fail due to excessive voltage drop on the system;

(c) to be capable of providing the electrical services necessary to start the main propulsion machinery from a dead ship condition. The emergency source of electrical power may be used to assist if it can provide power at the same time to those services required to be supplied by Section ~~3~~ 5.

Existing paragraph Pt 10, Ch 1, 2.2.2 *has been renumbered* Pt 9, Ch 2, 4.2.2.

~~2.2.3~~ 4.2.3 Arrangements are to be provided to prevent overloading of the generating set(s) supplying the electrical power that is/are required to maintain the ship in a normal operational and habitable condition. On loss of electrical power, arrangements are to be made for a standby generator set to be started, connected to the switchboard and essential services restarted in as short a time as is practicable. These load control, starting and restart functions may be achieved by the actions of suitably trained personnel but in ships with UMS notation the arrangements are to be automatic, *see also* ~~6.9~~ Ch 4, 4.9.

~~2.3~~ 4.3 Starting arrangements

Existing paragraphs Pt 10, Ch 1, 2, 2.3.1 *and* 2.3.2 *have been renumbered* Pt 9, Ch 2, 4.3.1 *and* 4.3.2.

~~2.3.2~~ 4.3.2 When the emergency source of electrical power is required to be used to restore propulsion from a dead ship condition, the emergency generator is to be capable of providing initial starting energy for the propulsion machinery within 30 minutes of the dead ship condition. The emergency generator capacity is to be sufficient for restoring propulsion in addition to supplying those services in Section ~~3~~ 5. *See* Pt 2, Ch 1,7 for dead ship condition starting arrangements.

~~2.4~~ 4.4 Prime mover governors

Existing paragraph Pt 10, Ch 1, 2.4.1 *and* 2.4.2 *have been renumbered* Pt 9, Ch 2, 4.4.1 *and* 4.4.2.

~~2.4.2~~ 4.4.2 The maximum electrical step load switched on or off is not to cause the frequency variation of the electrical supply to exceed the parameters given in ~~1.8.2~~ Ch 1, 1.2.1.

~~2.5~~ 4.5 Main propulsion driven generators not forming part of the main source of electrical power

Existing paragraph Pt 10, Ch 1, 2.5.1 *has been renumbered* Pt 9, Ch 2, 4.5.1.

~~2.5.1~~ 4.5.1 Generators and generator systems, having the ship's propulsion machinery as their prime mover but not forming part of the ship's main source of electrical power may be used whilst the ship is at sea to supply electrical services required for normal operational and habitable conditions provided that the requirements of ~~2.5.2~~ 4.5.2 to ~~2.5.4~~ 4.5.4 are satisfied.

Existing paragraphs Pt 10, Ch 1, 2.5.2 *to* 2.5.4 *have been renumbered* Pt 9, Ch 2, 4.5.2 *to* 4.5.4.

~~2.5.4~~ 4.5.4 In addition to the requirements of ~~2.2.3~~ 4.2.3, arrangements are to be fitted to automatically start and connect one of the generators forming the main source of power should the frequency variations exceed those permitted by the Rules.

■ *Section ~~3~~ 5*
Emergency and alternative sources of electrical power

Existing paragraphs Pt 10, Ch 1, 3.1.1 *to* 3.1.3 *have been renumbered* Pt 9, Ch 2, 5.1.1, 5.1.2 *and* 5.1.4.

~~3.1~~ 5.1 General

~~3.1.1~~ 5.1.1 The requirements of this Section apply to naval ships to be classed for unrestricted service. Alternative arrangements specified in accordance with the requirements of the ~~Naval Authority~~ Naval Administration may also be acceptable.

~~3.1.2~~ 5.1.2 A greater or lesser period than the 18 hour period specified in ~~3.2.7~~ 5.2.7 may be considered in conjunction with the operational requirements ~~of the Naval Authority~~ as specified and any assigned Service Restriction.

5.1.3 Where it is proposed that a dedicated emergency source of electrical power and its associated transitional source of power will not be provided, the installation is to comply with the requirements of 5.5.

~~3.1.3~~ 5.1.4 Where the main sources of electrical power are located in two or more compartments that are not contiguous with each other, and where each source has its own independent self-contained systems, including power distribution and control systems, such that a fire or casualty in any one of the compartments will not affect the power distribution from the other(s), or to the services required by ~~3.2.7~~ 5.2.7, the requirement of this Section will be satisfied without an additional emergency source of electrical power and its associated transitional source of power, provided that:

(a) there is at least one generating set complying with the requirements of ~~2.2~~ 4.2 and of sufficient capacity to meet the requirements of ~~3.2.7~~ 5.2.7 in at least two non-contiguous compartments; and

(b) the generator sets referred to in ~~3.1.3(a)~~ 5.1.3(a) and their self-contained systems are installed such that one of them remains operable and readily accessible after damage or flooding in any one compartment; and

(c) the generator sets referred to in ~~3.1.3(a)~~ 5.1.3(a) are capable of being automatically started on loss of the power supplied by the other main source(s) of electrical power and supplying the services required by ~~3.2.7~~ 5.2.7 as quickly as is safe and practicable subject to a maximum of 45 seconds or provided with a transitional source of emergency electrical power as specified in ~~3.2.9~~ 5.2.9; and

(d) the number and arrangements of generators is to allow for maintenance at sea of any one generator without affecting the ability to supply electrical power to the services in ~~3.2.7~~ 5.2.7 from either of at least two compartments; and

(e) the requirements of this Chapter applicable to the emergency source or any associated equipment are to be applied to the main source complying with ~~2.2~~ 4.2, or any associated equipment.

~~3.2~~ 5.2 Emergency source of electrical power

Existing paragraphs Pt 10, Ch 1, 3.2.1 *to* 3.2.15 *have been renumbered* Pt 9, Ch 2, 5.2.1 *to* 5.2.15.

~~3.2.5~~ 5.2.5 Where compliance with ~~3.2.3~~ 5.2.3 or ~~3.2.4~~ 5.2.4 is not practicable, details of the proposed arrangements are to be submitted.

Existing paragraph Pt 10, Ch 1, 3.2.6 *has been renumbered* Pt 9, Ch 2, 5.2.6.

(*Part only shown*)

~~3.2.7~~ 5.2.7 The electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter or for the period specified by the Naval Administration, *see* 5.1.2, if they depend upon an electrical source for their operation:

(c) For a period of not less than 18 hours:
  (ii) The radiocommunications, as required by Amendments to SOLAS 1974, Chapter IV, *see also* ~~3.5~~ Ch 1, 5.5 Radio installation.

(d) For a period of not less than 18 hours:
  (ii) the navigational aids ~~as required by the Naval Authority~~;

(g) For a period of half an hour:
  (i) any watertight doors if electrically-operated, together with their control, indication and alarm circuits;

(h) Where applicable, the services required by ~~2.3.2~~ 4.3.2.

(*Part only shown*)

~~3.2.8~~ 5.2.8 The emergency source of electrical power may be either a generator or an accumulator battery, which is to comply with the following:

(a) Where the emergency source of electrical power is a generator it is to be:
  (ii) started automatically upon failure of the main source of electrical power supply unless a transitional source of emergency electrical power in accordance with ~~3.2.9~~ 5.2.9 is provided; where the emergency generator is automatically started, it is to be automatically connected to the emergency switchboard; those services referred to in ~~3.2.7~~ 5.2.7 are to be connected automatically to the emergency generator; and
  (iii) provided with a transitional source of emergency electrical power as specified in ~~3.2.9~~ 5.2.9 unless an emergency generator is provided capable both of supplying the services mentioned in that paragraph and of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 seconds.

(b) Where the emergency source of electrical power is an accumulator battery it is to be capable of:
  (iii) immediately supplying at least those services specified in ~~3.2.7~~ 5.2.7; and

~~*3.2.9*~~ *5.2.9* The transitional source of emergency electrical power where required by ~~3.2.8~~ 5.2.8 is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and is to be so arranged as to supply automatically in the ~~3.2.7~~ 5.2.7(a) event of failure of either the main or the emergency source of electrical power for half an hour at least the following services if they depend upon an electrical source for their operation:

(a) the lighting required by ~~3.2.7~~ 5.2.7(a), (b) and (c). For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

(b) all services required by ~~3.2.7~~ 5.2.7(d)(i), (iii) and (iv) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

(c) Power to operate the watertight doors at least three times, i.e., closed-open-closed against an adverse list of 15°, but not necessarily all of them simultaneously, together with their control, indication and alarm circuits as required by ~~3.2.7~~ 5.2.7(g)(i).

Existing paragraphs Pt 10, Ch 1, 3.2.10 *to* 3.2.15 *have been renumbered* Pt 9, Ch 2, 5.2.10 *to* 5.2.15.

~~3.3~~ 5.3 Starting arrangements

Existing paragraph Pt 10, Ch 1, 3.3.1 *has been renumbered* Pt 9, Ch 2, 5.3.1.

~~3.4~~ 5.4 Prime mover governor

Existing paragraph Pt 10, Ch 1, 3.4.1 *has been renumbered* Pt 9, Ch 2, 5.4.1.

~~*3.4.1*~~ *5.4.1* Where the emergency source of power is a generator, the governor is to comply with ~~2.5~~ 4.4.

5.5 Alternative sources of emergency electrical power

5.5.1 Where it is proposed that a dedicated emergency source of electrical power and its associated transitional source of power will not be provided, the main source of electrical power and associated equipment is to meet the requirements of 5.5.2 to 5.5.8. For such installations where the Rules specify a supply from the emergency source of power, this is to be achieved by an alternative supply meeting the requirements of 5.5.2 to 5.5.8.

5.5.2 The main sources of electrical power are to be

(a) separated and located in two or more compartments that are not contiguous with each other;

(b) self-contained and arranged to be independent such that each system can operate without recourse to the other main source(s) including power distribution and any associated converting equipment and control systems;

(c) arranged such that a fire or casualty in any one of the compartments will not affect the electrical power distribution from the other(s), or to the services required by 5.2.7.

5.5.3 The generator sets referred to in 5.5.2 (a) are to be capable of being started automatically on loss of the power supplied by the other main source(s) of electrical power and supplying the services required by 5.2.7 as quickly as is safe and practicable subject to a maximum of 45 seconds, or provided with a transitional source of emergency electrical power as specified in 5.2.9.

5.5.4 The number and arrangements of generators are to allow for maintenance at sea of any one generator without affecting the ability to comply with 5.5.2.

5.5.5 Starting arrangements of main sources of electrical power are to comply with the requirements of Pt 2, Ch 1, 7.15.

5.5.6 Where these Rules specify that a service is required to be connected to both the main and emergency source of electrical power or is to be connected to the emergency switchboard, then these services are to be served by at least two individual circuits from the separated main sources of electrical power with arrangements to transfer between the two sources. The supplies are to be separated in their switchboard and throughout their length as widely as is practicable without the use of common feeders, protective devices, control circuits or controlgear assemblies, so that any single electrical fault will not cause the loss of both supplies.

5.5.7 Provision is to be made for periodic testing to demonstrate services required by 5.2.7 can be supplied automatically following the loss of one main source of electrical power.

5.5.8 To demonstrate compliance with the requirements of 5.5.2 to 5.5.4, a risk assessment of the electrical, mechanical and piping arrangements is to be carried out demonstrating that a single point failure such as a fire within a space would not render the systems incapable of supplying those services required in an emergency, *see* Vol 2, Pt 1, Ch 2, 17.

~~3.5~~ 5.6 Radio installation

Existing paragraph Pt 10, Ch 1, 3.5.1 *to* 3.5.7 *have been renumbered* Pt 9, Ch 2, 5.5.1 *to* 5.5.7.

~~*3.5.1*~~ *5.6.1* Every fixed radio installation ~~as required by the Naval Authority~~ is to be provided with reliable, permanently arranged electrical lighting, independent of the main and emergency sources of electrical power, for the adequate illumination of the radio controls for operating the radio installation.

~~*3.5.2*~~ *5.6.2* A reserve source or sources of energy is to be provided on every ship, for the purpose of conducting distress and safety radio communications, in the event of failure of the ship's main and emergency sources of electrical power. The reserve source, or sources, of energy is to be capable of simultaneously operating the VHF radio installation and, as appropriate for the sea or sea area for which the ship is equipped, either the MF radio installation, the MF/HF radio installation, or the INMARSAT ship earth station and any of the additional loads mentioned in ~~3.5.4~~ 5.5.4, ~~3.5.5~~ 5.5.5 and ~~3.5.7~~ 5.5.7 for a period of at least one hour. The reserve source or sources of energy need not supply independent HF and MF radio installations at the same time.

Existing paragraph Pt 10, Ch 1, 3.5.1 *to* 3.5.7 *have been renumbered* Pt 9, Ch 2, 5.5.1 *to* 5.5.7.

~~3.5.4~~ 5.6.4 Where, in addition to the VHF radio installation, two or more of the other radio installations, referred to in ~~3.5.2~~ 5.5.2, can be connected to the reserve source or sources of energy, the reserve source or sources are to be capable of simultaneously supplying, for the period specified by ~~3.5.2~~ 5.5.2, the VHF radio installation and:

(a) all other radio installations which can be connected to the reserve source or sources of energy at the same time; or

(b) whichever of the other radio installations will consume the most power, if only one of the other radio installations can be connected to the reserve source or sources of energy at the same time as the VHF radio installation.

~~3.5.5~~ 5.6.5 The reserve source or sources of energy may be used to supply the electrical lighting required by ~~3.5.1~~ 5.5.1.

Existing paragraph Pt 10, Ch 1, 3.5.6 *has been renumbered* Pt 9, Ch 2, 5.6.6*.*

~~3.5.7~~ 5.6.7 If an uninterrupted input of information from the ship's navigational or other equipment to a radio installation as referred to in ~~3.5.2~~ 5.6.2 is needed to ensure its proper performance, means are to be provided to ensure the continuous supply of such information in the event of failure of the ship's main or emergency source of electrical power.

■ *Section 6*
~~System design – Protection~~ Generators

Existing sub-Sections Pt 10, Ch 1, 9.1 *to* 9.5 *have been renumbered* Pt 9, Ch 2, 6.1 *to* 6.5.

Existing paragraphs Pt 10, Ch 1, 9.1.10 *and* 9.1.13 *have been renumbered* Pt 9, Ch 2, 6.1.3 *and* 6.1.5.

~~9.1~~ 6.1 General requirements

6.1.1 Generators are to comply with the general requirements as specified within Ch 3, 6.1.

6.1.2 The application of shaft material for main engine-driven generators where the shaft is part of the propulsion shafting is to comply with the *Rules for Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials) and are to be manufactured under LR survey.

~~9.1.10~~ 6.1.3 ~~Propulsion motors and generators~~ Generators that form part of electrical propulsion systems are to have at least one embedded temperature detector (ETD) in each phase of the machine winding in locations which may be subjected to the highest temperature. Where there are two coil sides per slot the ETD's are to be located between the insulated coil sides in the slot, *see* ~~16.1.3~~ Pt 4, Ch 1, 4.1.4.

6.1.4 A high bearing temperature alarm is to be provided where the generators of 100 kW and above are supplied with forced lubrication.

~~9.1.13~~ 6.1.5 A low lubricating oil pressure alarm is to be provided for generators ~~and electric propulsion motors~~ that are supplied with forced lubrication.

~~9.2~~ 6.2 ~~Rating~~ Ratings

6.2.1 For generator ratings the applicable requirements of Pt 9, Ch 3, 6.2 are to be complied with.

~~9.2.1~~ 6.2.2 ~~Generators, including their excitation systems, and continuously rated motors are to be suitable for continuous duty at their full rated output at maximum cooling air or water temperature for an unlimited period, without the limits of temperature rise in 9.3 being exceeded.~~ Generators are to be capable of an overload power of not less than 10 per cent at their rated power factor for a period of 15 minutes without injurious heating. ~~Other machines are to be rated in accordance with the duty which they have to perform and, when tested under rated load conditions, the temperature rise is not to exceed the values in 9.3.~~

~~9.3~~ 6.3 Temperature rise

6.3.1 For generator temperature rise the applicable requirements of Pt 9, Ch 3, 6.3 are to be complied with.

~~9.4~~ 6.4 Generator control

Existing paragraph Pt 10, Ch 1, 9.4.1 *has been renumbered* Pt 9, Ch 2, 6.4.1.

Existing paragraphs Pt 10, Ch 1, 9.4.1 *to* 9.4.8 *have been renumbered* Pt 9, Ch 2, 6.4.1 *to* 6.4.8.

~~9.4.2~~ 6.4.2 The voltage regulation of any alternating current generator with its regulating equipment is to be such that at all loads, from zero to full load at rated power factor, the rated voltage is maintained within ±2,5 per cent under steady conditions. There is to be provision at the voltage regulator to adjust the generator no-load voltage.

~~9.4.8~~ 6.4.8 For **ELS** notation, *see* ~~1.9.6~~ Ch 1, 3.2.5.

~~9.5~~ 6.5 Overloads

Existing paragraph Pt 10, Ch1, 9.5.1(a) *has been renumbered* Pt 9, Ch 2, 6.5.1.

(*Part only shown*)

~~9.5.1~~ 6.5.1 ~~Machines are to withstand on test, without injury, the following momentary overloads:~~

~~(a) **Generators.** An excess current of 50 per cent for 15 seconds after attaining the temperature rise corresponding to rated load, the terminal voltage being maintained as near the rated value as possible. The foregoing does not apply to the overload torque capacity of the prime mover.~~

Machines are to withstand on test, without injury, the momentary overload of an excess current of 50 per cent for 30 seconds after attaining the temperature rise corresponding to rated load, the terminal voltage being maintained as near the rated value as possible. The foregoing does not apply to the overload torque capacity of the prime mover.

~~9.6~~ 6.6 Machine enclosure

6.6.1 For generator enclosures the applicable requirements of Pt 9, Ch 3, 6.5 are to be complied with.

~~9.7~~ 6.7 Direct current machines

6.7.1 For direct current generators the applicable requirements of Pt 9, Ch 3, 6.6 are to be complied with.

~~9.8~~ 6.8 Survey and testing

6.8.1 For survey and testing of generators the applicable requirements of Pt 9, Ch 3, 6.7 are to be complied with.

■ *Section ~~12~~ 7*
Batteries

~~12.1~~ 7.1 General requirements

Existing paragraphs Pt 10, Ch 1, 12.1.1 *to* 12.1.3 *have been renumbered* Pt 9, Ch 2, 7.1.1 *to* 7.1.3.

~~12.2~~ 7.2 Construction

Existing paragraph Pt 10, Ch 1, 12.2.1 *has been renumbered* Pt 9, Ch 2, 7.2.1.

~~12.3~~ 7.3 Location

Existing paragraph Pt 10, Ch 1, 12.3.1 *to* 12.3.10 *have been renumbered* Pt 9, Ch 2, 7.3.1 *to* 7.3.10.

~~12.3.2~~ 7.3.2 Vented batteries connected to a charging device with a power output within the range 0,2 kW to 2 kW, calculated from the maximum obtainable charging current and the nominal voltage of the battery, are to be installed in accordance with ~~12.3.1~~ 7.3.1, or may be installed in a box within a well ventilated machinery or similar space.

Existing paragraph Pt 10, Ch 1, 12.3.3 *has been renumbered* Pt 9, Ch 2, 7.3.3.

~~12.3.4~~ 7.3.4 Where more than one charging device is installed for any battery or group of batteries in one location, the total power output is to be used to determine the installation requirements of ~~12.3.1~~ 7.3.1, ~~12.3.2~~ 7.3.2 or ~~12.3.3~~ 7.3.3.

~~12.3.5~~ 7.3.5 Valve-regulated sealed batteries may be located in compartments with standard marine or industrial electrical equipment provided that the ventilation requirements of ~~12.5.10~~ 7.5.10 and the charging requirements of ~~12.6.4~~ 7.6.4 and ~~12.6.5~~ 7.6.5 are complied with. Equipment that may produce arcs, sparks or high temperatures in normal operation is not to be in close proximity to battery vent plugs or pressure relief valve outlets.

Existing paragraphs Pt 10, Ch 1, 12.3.6 *to* 12.3.8 *have been renumbered* Pt 9, Ch 2, 7.3.6 *to* 7.3.8.

~~12.3.9~~ 7.3.9 Only electrical equipment necessary for operational reasons and for the provision of lighting is to be installed in compartments provided in compliance with ~~12.3.1~~ 7.3.1, the compartment ventilation exhaust ducts and zones within a 1,5 m radius of the ventilation outlet(s). Such electrical equipment is to be certified for group IIC gases and temperature Class T1 in accordance with the applicable parts of IEC 60079:~~*Electrical apparatus for explosive gas atmospheres*~~ *Explosive atmospheres*, or an acceptable and relevant National Standard.

~~12.3.10~~ 7.3.10 A permanent notice is to be prominently displayed adjacent to battery installations advising personnel that replacement batteries are to be of an equivalent performance type. For valve-regulated sealed batteries, the notice is to advise of the requirement for replacement batteries to be suitable with respect to products of electrolysis and evaporation being allowed to escape from cells to the atmosphere, *see also* ~~1.5.5~~ Ch 1, 1.7.6.

~~12.4~~ 7.4 Installation

Existing paragraphs Pt 10, Ch 1, 12.4.1 *to* 12.4.4 *have been renumbered* Pt 9, Ch 2, 7.4.1 *to* 7.5.10.

~~12.5~~ 7.5 Ventilation

Existing paragraphs Pt 10, Ch 1, 12.5.1 *to* 12.5.10 *have been renumbered* Pt 9, Ch 2, 7.5.1 *to* 7.5.3.

~~12.5.4~~ 7.5.4 Mechanical exhaust ventilation complying with ~~12.5.9~~ 7.5.9 is to be provided for battery installations connected to a charging device with a total maximum power output of more than 2 kW. Also, to minimise the possibility of oxygen enrichment, compartments and spaces containing batteries with boost charging facilities are to be provided with

mechanical exhaust ventilation irrespective of the charging device power output.

~~12.5.5~~ 7.5.5 The ventilation system for battery compartments and boxes, other than boxes located on open deck or in spaces to which ~~12.3.2~~ 7.3.2, ~~12.3.3~~ 7.3.3 and ~~12.3.5~~ 7.3.5 refer, is to be separate from other ventilation systems. The exhaust ducting is to be led to a location in the open air, where any gases can be safely diluted, away from possible sources of ignition and openings into spaces where gases may accumulate.

Existing paragraphs Pt 10, Ch 1, 12.5.6 *to* 12.5.9 *have been renumbered* Pt 9, Ch 2, 7.5.6 *to* 7.5.9.

~~12.5.10~~ 7.5.10 The ventilation rate for compartments containing valve-regulated sealed batteries may be reduced to 25 per cent of that given in ~~12.5.9~~ 7.5.9.

~~12.6~~ 7.6 Charging facilities

Existing paragraphs Pt 10, Ch 1, 12.6.1 *to* 12.6.5 *have been renumbered* Pt 9, Ch 2, 7.6.1 *to* 7.6.5.

~~12.6.4~~ 7.6.4 Arrangements are to be fitted to automatically control the charging rate of valve regulated sealed batteries so as to prevent overcharging which may lead to an excessive evolution of gas. These arrangements are to take account of any ~~Naval Authority~~ requirements for prolonged operation under close down conditions.

Existing paragraph Pt 10, Ch 1, 12.6.5 *has been renumbered* Pt 9, Ch 2, 7.6.5.

~~12.7~~ 7.7 Recording of batteries for emergency and essential services

Existing paragraph Pt 10, Ch 1, 12.7.1 *to* 12.7.4 *has been renumbered* Pt 9, Ch 2, 7.7.1 *to* 7.7.4.

~~12.7.2~~ 7.7.2 Procedures are to be put in place and documented to ensure that, where batteries are replaced, they are of an equivalent performance type, *see also* ~~1.5.5~~ Ch 1, 1.7.6.

~~12.7.3~~ 7.7.3 When additions or alterations are proposed to the existing batteries for essential and emergency services, the schedule and replacement procedure documentation are to be updated to reflect the proposed installation and submitted in accordance with ~~1.5.2~~ 1.7.1.

Existing paragraph Pt 10, Ch 1, 12.7.4 *has been renumbered* Pt 9, Ch 2, 7.7.4.

■ *Section ~~4~~ 8*
External source of electrical power

~~4.1~~ 8.1 Temporary external supply

Existing paragraphs Pt 10, Ch 1, 4.1.1 *to* 4.1.5 *have been renumbered* Pt 9, Ch 2, 8.1.1 *to* 8.1.5.

■ *Section 9*
Other sources of electrical power

9.1 General

9.1.1 Other sources of power and storage devices not covered by the Sections above are to be subject to special considerations and are to satisfy the requirements of Pt 5, Ch 1.

Volume 2, Part 9

Electrotechnical Systems

Chapter 3

Electrical Power Distribution and Equipment

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy of electrical distribution system and connected consumers.

This Chapter details the requirements for sub-systems and equipment within the boundary of electrical power distribution and are applicable for main and emergency auxiliary power systems as well as integrated electrical power generation and propulsion systems.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77 NATO Naval Ship Code,* Chapter IV, Regulation 10.

■ *Section 1*

Functional requirements

1.1 Functional requirements

1.1.1 Electrical power shall be safely distributed to consumers throughout the vessel.

■ *Section 2*

Performance requirements

2.1 Performance requirements

2.1.1 Electrical equipment is to be suitable for the quality of electrical power supply encountered on board.

2.1.2 Electrical equipment and distribution systems are to meet the requirements of Chapter 4.

2.1.3 The electrical system voltages and frequencies shall be selected to ensure safe provision of electrical power to systems and to minimise the risk of exposure to personnel.

2.1.4 The design of the type and configuration of the distribution system is to consider earthing arrangements to minimise the risk to personnel and equipment under normal and foreseeable abnormal conditions.

2.1.5 The number, size, installation and arrangement of electrical switchboards and distribution centres shall be suitable for the functional requirements of the vessel.

2.1.6 The design of the electrical distribution system is to ensure that a single point of failure will not result in unavailability of both main and emergency sources of electrical power.

2.1.7 Cables shall be installed such that risk of injury to personnel or damage to the system is minimised when equipment is operating in foreseeable conditions or under reasonable foreseeable abnormal conditions.

2.1.8 Where a single consumer requires a main and emergency supply of electrical power, they shall be separated as widely as is practicable.

2.1.9 The continuity of supply to services that are essential for safety in an emergency shall be ensured under all normal and reasonably foreseeable abnormal conditions.

2.1.10 The continuity of supply to essential services is to be ensured under normal operation and defined abnormal conditions.

2.1.11 Suitable arrangements for the isolation and switching of distribution circuits shall be provided.

2.1.12 Installation of cables shall not cause mutual interference between systems.

2.1.13 A means to detect insulation breakdown with respect to earth within equipment and distribution systems and to alert the Operator shall be provided.

2.1.14 Cables shall be installed such that risk of injury to personnel or damage to the system is minimised when equipment is operating in foreseeable or under fault conditions.

2.1.15 Exposed metal parts of electrical machines or equipment which are not intended to be live but which may become live under fault conditions shall be earthed.

2.1.16 Essential safety functions shall be supplied using fire-resistant cable.

2.1.17 Electrical equipment and distribution systems shall be suitably protected from mechanical damage.

2.1.18 Alternative arrangements for cooling of essential machinery and systems in the event of a forced cooling system failure shall be provided.

2.1.19 Personnel, equipment and platform are to be protected from the risk of static electricity.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 10 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section ~~5~~ 4*
Supply and distribution

~~5.1~~ 4.1 Systems of supply and distribution

Existing paragraphs Pt 10, Ch 1, 5.1.1 *to* 5.1.7 *have been renumbered* Pt 9, Ch 3, 4.1.1 *to* 4.1.7.

~~5.1.1~~ 4.1.1 The following systems of generation and distribution are acceptable:
(a) d.c., two-wire;
(b) a.c., single-phase, two-wire;
(c) a.c., three-phase:
  (i) three-wire insulated;
  (ii) three-wire with neutral solidly earthed or earthed through an impedance;
  (iii) four-wire with neutral solidly earthed but without hull return.

NOTE:
Where the **ELS** notation is to be assigned, earthed systems are permitted only when the additional requirements of ~~5.5.7~~ Ch 3, 4.5.7 are satisfied. *See also* ~~1.9.4~~ Ch 1, 3.2.3.

~~5.2~~ 4.2 Essential services

Existing paragraphs Pt 10, Ch 1, 5.2.1 *to* 5.2.4 *have been renumbered* Pt 9, Ch 3, 4.2.1 *to* 4.2.4.

~~5.2.1~~ 4.2.1 Essential services that are required to be duplicated are to be served by individual circuits, separated in their switchboard or section board and throughout their length as widely as is practicable without the use of common feeders, protective devices, control circuits or ~~control gear~~ controlgear assemblies, so that any single fault will not cause the loss of both services.

~~5.2.2~~ 4.2.2 Where ~~5.2.1~~ 4.2.1 is applicable the main busbars of the switchboard, or section boards, are to be capable of being split, by a multi-pole linked circuit-breaker, disconnector or switch-disconnector, into at least two independent sections, each supplied by at least one generator, either directly or through a converter. The essential services are to be equally divided, as far as is practicable, between the independent sections.

~~5.2.3~~ 4.2.3 Where ~~5.2.2~~ 4.2.2 is applicable, provision is to be made to transfer to a temporary circuit those essential services which are not required to be, and have not been, duplicated in the event of loss of their normal section of switchboard or section-board.

~~5.2.4~~ 4.2.4 A Risk Based Assessment (RA) is to be carried out in accordance with the requirements of Pt 1, Ch 2,17. The RA is to verify the availability of electrical power to essential services (*see* ~~1.6.1~~ Pt 1, Ch 1, 3.1.5) in the event of a failure in the power supply and distribution system. The RA is to address the different system operating modes and configurations. The RA should include relevant mechanical failures which may have significant effects on the electrical power and distribution system, i.e., prime mover failures causing loss of electrical power supplies used to provide essential services. An analysis carried out by applying the relevant generic failure modes listed in IEC 60812:1985, *Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)*, to the system and equipment identified in the single line diagram of the electrical system (*see* ~~1.2.2~~ Ch 1, 1.4.4) would generally be acceptable.

~~5.3~~ 4.3 Isolation and switching

Existing paragraphs Pt 10, Ch 1, 5.3.1 *to* 5.3.8 *have been renumbered* Pt 9, Ch 3, 4.3.1 *to* 4.3.8.

~~5.3.1~~ 4.3.1 The incoming and outgoing circuits from every switchboard or section board are to be provided with a means of isolation and switching to permit each circuit to be switched off:
(a) on load;
(b) for mechanical maintenance;
(c) in an emergency to prevent or remove danger.
In addition, the requirements of ~~5.3.2~~ 4.3.2 and ~~5.3.3~~ 4.3.3 are to be complied with.

~~5.3.2~~ 4.3.2 Isolation and switching is to be by means of a circuit-breaker or switch arranged to open and close simultaneously all insulated poles. Where a switch is used as the means of isolation and switching, it is to be capable of:
(a) switching off the circuit on load;
(b) withstanding, without damage, the overcurrents which may arise during overloads and short-circuit. In addition, these requirements do not preclude the provision of single pole control switches in final sub-circuits, for example light switches.
For circuit-breakers, *see* ~~6.5 and 7.3~~ 5.3 and Ch 4, 4.5.

Existing paragraph Pt 10, Ch 1, 5.3.3 *has been renumbered* Pt 9, Ch 3, 4.3.3.

~~5.3.4~~ 4.3.4 Where a section board, distribution board or item of equipment can be supplied by more than one circuit, a switching device is to be provided to permit each incoming circuit to be isolated and the supply transferred to the alternative circuit. In addition, the requirements of ~~5.3.5~~ 4.3.5 and ~~5.3.6~~ 4.3.6 are to be complied with.

~~5.3.5~~ 4.3.5 The switching device required by ~~5.3.4~~ 4.3.4 is to be situated within or adjacent to the section board, distribution board or item of equipment. Where necessary, interlocking arrangements are to be provided to prevent circuits being inadvertently energised.

~~5.3.6~~ 4.3.6 A notice is to be fixed to any section board, distribution board or item of equipment to which ~~5.3.4~~ 4.3.4 applies warning personnel before gaining access to live parts of the need to open the appropriate circuit-breakers or switches, unless an interlocking arrangement is provided so that all circuits concerned are isolated before access is gained.

~~5.3.7~~ 4.3.7 Where high voltage equipment is contained in a room, or protected area, which also forms its enclosure, the access door(s) is (are) to be so interlocked that it (they) cannot be opened until the high voltage supply(ies) to the equipment is (are) switched off. Provision is also to be made to enable the equipment and its cable(s) to be earthed down and any stored energy dissipated, sufficient to ensure personnel safety.

~~5.3.8~~ 4.3.8 The access to the space(s) described in ~~5.3.7~~ 4.3.7 ~~are~~ is to be suitably marked to indicate the danger of high voltage.

~~5.4~~ 4.4 Insulated distribution systems

Existing paragraphs Pt 10, Ch 1, 5.4.1 *to* 5.4.3 *have been renumbered* Pt 9, Ch 3, 4.4.1 *to* 4.4.3.

~~5.4.1~~ 4.4.1 A device(s) is (are) to be installed for every insulated distribution system, whether primary or secondary, for power, heating and lighting circuits, to continuously monitor the insulation level to earth and to operate an alarm in the engine control room, or equivalent attended position, in the event of an abnormally low level of insulation resistance~~, *see also* Pt 9, Ch 1,3.2~~.

Existing paragraphs Pt 10, Ch 1, 5.4.2 *and* 5.4.3 *have been renumbered* Pt 9, Ch 3, 4.4.2 *and* 4.4.3.

~~5.5~~ 4.5 Earthed distribution systems

Existing paragraphs Pt 10, Ch 1, 5.5.1 *to* 5.5.7 *have been renumbered* Pt 9, Ch 3, 4.5.1 *to* 4.5.7.

~~5.5.7~~ 4.5.7 Where the ELS notation is to be assigned, earthed systems are not permitted unless they are isolated from the main generation and distribution system, e.g., through transformers and/or motor generator sets. *See also* ~~1.9.4~~ Ch 1, 3.2.3.

~~5.6~~ 4.6 Diversity factor

Existing paragraphs Pt 10, Ch 1, 5.6.1 *and* 5.6.2 *have been renumbered* Pt 9, Ch 3, 4.6.1 *and* 4.6.2.

~~5.7~~ 4.7 Lighting circuits

4.7.1 Lighting circuits are to comply with the requirements of Ch 6.

~~5.8~~ 4.8 Motor circuits

Existing paragraph Pt 10, Ch 1, 5.8.1 *has been renumbered* Pt 9, Ch 3, 4.8.1.

~~5.8.1~~ 4.8.1 A separate final sub-circuit is to be provided for every motor for essential services, *see* ~~1.6.1~~ Pt 1, Ch 1, 3.1.5.

~~5.9~~ 4.9 Motor control

Existing paragraphs Pt 10, Ch 1, 5.9.1 *to* 5.9.4 *have been renumbered* Pt 9, Ch 3, 4.9.1 *to* 4.9.4.

~~5.9.1~~ 4.9.1 Every electric motor is to be provided with efficient means for starting and stopping so placed as to be easily operated by the person controlling the motor. Every motor above 0,5 kW is to be provided with control apparatus as given in ~~5.9.2~~ 4.9.2 to ~~5.9.4~~ 4.9.4.

Existing paragraph Pt 10, Ch 1, 5.9.2 *has been renumbered* Pt 9, Ch 3, 4.9.2.

~~5.9.3~~ 4.9.3 Means for automatic disconnection of the supply in the event of excess current due to mechanical overloading of the motor are to be provided, *see also* ~~6.11~~ Ch 4, 4.11.

~~5.9.4~~ 4.9.4 Motor ~~control gear~~ controlgear is to be suitable for the starting current and for the full load rated current of the motor.

■ *Section ~~7~~ 5*
Switchgear and ~~control gear~~ controlgear assemblies

Existing paragraph Pt 10, Ch 1, 7.1.1 *has been renumbered* Pt 9, Ch 3, 5.1.1.

~~7.1~~ 5.1 General requirements

~~7.1.1~~ 5.1.1 Switchgear and ~~control gear~~ controlgear assemblies and their components are to comply with ~~one of~~ the following standards as appropriate for the nominal voltage, and amended where necessary for ambient temperature and other environmental conditions:

(a) IEC 61439: *Low-voltage switchgear and ~~control gear~~ controlgear assemblies (relevant parts)*;
(b) IEC 62271-200: *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*;
(c) IEC 62271-201: *High-voltage switchgear and ~~control gear~~ controlgear – Part 201: AC insulation-enclosed switchgear and ~~control gear~~ controlgear for rated voltages above 1 kV and up to and including 52 kV*;

(d) IEC 60092-503: *Electrical installations in ships – Part 503: Special features – AC supply systems with voltages in the range of above 1 kV up to and including 15 kV*;

~~(d)~~(e) IEC 60255: ~~*Electrical Relays*~~ *Measuring relays and protection equipment;* or

~~(e)~~(f) an acceptable and relevant National Standard.~~; or~~

~~(f) specialised acceptable and relevant Naval Standards.~~

In addition, the requirements of ~~7.2 to 7.19~~ 5.2 to 5.19 are to be complied with.

~~7.2~~ 5.2 Busbars

Existing paragraphs Pt 10, Ch 1, 7.2.1 *and* 7.2.2 *have been renumbered* Pt 9, Ch 3, 5.2.1 *and* 5.2.2.

~~7.3~~ 5.3 Circuit-breakers

Existing paragraphs Pt 10, Ch 1, 7.3.1 *to* 7.3.6 *have been renumbered* Pt 9, Ch 3, 5.3.1 *to* 5.3.6.

~~*7.3.1*~~ *5.3.1* Circuit-breakers are to comply with one of the following standards amended where necessary for ambient temperature:

(a) IEC 60947-2: *Low-voltage switchgear and ~~Control gear~~ controlgear – Part 2: circuit-breakers*; or

(b) IEC 62271-100: *High-voltage switchgear and ~~control gear~~ controlgear – ~~Pt~~ Part 100: ~~High-voltage alternating-current circuit-breakers~~ Alternating current circuit-breakers*;

(c) an acceptable and relevant National Standard.

Type test reports to verify the characteristics of a circuit-breaker are to be submitted for consideration when required.

Existing paragraph Pt 10, Ch 1, 7.3.2 *to* 7.3.4 *have been renumbered* Pt 9, Ch 3, 5.3.2 *to* 5.3.4.

~~*7.3.5*~~ *5.3.5* Where the means of setting adjustable protection characteristics are not durably marked and locked in position and cannot be visually inspected (e.g., electronic storage), the setting of characteristics is to be recorded in accordance with an acceptable quality management system with a copy of the records included in the details retained on board, *see* ~~6.1.4~~ Ch 4, 4.1.4.

Existing paragraph Pt 10, Ch 1, 7.3.6 *has been renumbered* Pt 9, Ch 3, 5.3.6.

~~7.4~~ 5.4 Contactors

~~*7.4.1*~~ *5.4.1* High-voltage contactors are to comply with one of the following standards amended where necessary for ambient temperature:

(a) IEC ~~60470: *High-voltage alternating-current contactors*~~ 62271-106: *High-voltage switchgear and controlgear – Part 106: Alternating current contactors, contactor-based controllers and motor-starters*; or

(b) an acceptable and relevant National Standard.

Type test reports to verify the characteristics of a contactor are to be submitted for consideration when required.

Existing paragraph Pt 10, Ch 1, 7.4.1 *and* 7.4.2 *have been renumbered* Pt 9, Ch 3, 5.4.1 *and* 5.4.2.

Existing sub-Sections Pt 10, Ch 1, 7.9, 7.19 and 7.5 *have been renumbered* Pt 9, Ch 3, 5.5 to 5.7.

~~7.9~~ 5.5 Fuses

~~*7.9.1*~~ *5.5.1* Fuses are to comply with one of the following standards, amended where necessary for ambient temperature:

(a) IEC 60269 *(all parts)*: *Low-voltage fuses*; ~~or~~

(b) IEC 60282-1: *High-voltage fuses – Part 1: Current-limiting fuses*; or

(c) an acceptable and relevant National Standard for enclosed current-limiting fuses.

Type test reports to verify the characteristics of a fuse are to be submitted for consideration when required.

~~7.19~~ 5.6 Disconnectors and switch-disconnectors

~~*7.19.1*~~ *5.6.1* Disconnectors and switch-disconnectors are to comply with one of the following standards, amended as necessary for ambient temperature and other environmental conditions:

(a) IEC 600947-3: ~~*Low voltage switchgear and control gear Part 3: switches, disconnectors, switch-disconnectors and fuse combination units.*~~ *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*;

(b) IEC 62271-102: *High-voltage switchgear and* ~~control gear~~ controlgear – *Pt 102: High-voltage alternating current disconnectors and earthing switches*; or

(c) an ~~Acceptable~~ acceptable and relevant National Standard.

Type test reports to verify the characteristics of a disconnector or switch-disconnector are to be submitted for consideration when required.

~~7.5~~ 5.7 Creepage and clearance distances

~~*7.5.1*~~ *5.7.1* The shortest distances between conductive parts and between conductive parts and earth, in air or along the surface of an insulating material, are to be suitable for the rated voltage, having regard to:

- the nature of the insulating material;
- the transient over~~,~~ voltages developed by switching and fault conditions; and
- the environment into which the assembly will be installed.

Each assembly type is to be subjected to an impulse voltage test in accordance with its constructional Standard or, alternatively, the minimum distances for bare conductive parts in switchgear and ~~control gear~~ controlgear assemblies given in Table ~~1.7.1~~ 3.5.1 are to be used.

~~*7.5.2*~~ *5.7.2* For assemblies with a rated voltage of up to and including 1kV, the requirement of ~~7.5.1~~ 5.7.1 may be met by complying with IEC 60092-302: *Electrical installations in ships – Part 302: Low-voltage switchgear and ~~control gear~~* controlgear *assemblies*:

(a) Tables ~~1.7.1~~ 3.5.1 and ~~1.7.2~~ 3.5.2 indicate the minimum clearance and creepage distances normally allowed.

(b) For assemblies installed in spaces where the environmental conditions are in excess of pollution degree 3 (that is, conductive pollution occurs or dry, non-conductive pollution occurs which is expected to be conductive due to condensation) as defined in

IEC 61439-1, *Low-voltage switchgear and ~~control gear~~ controlgear assemblies – Part 1: General requirements; the clearance distances for non-verified assemblies* are to be used.

(c) A minimum creepage distance of 16 mm is permitted for assemblies verified in accordance with the requirements of IEC 61439-2, *Low-voltage switchgear and ~~control gear~~ controlgear assemblies – Part 2: Power switchgear and ~~control gear~~ controlgear assemblies*.

(d) An alternative relevant National or International Standard may be used when an acceptable justification is submitted as part of the documentation required by ~~1.3.3~~ Ch 1, 1.5.3.

Table ~~1.7.1~~ 3.5.1 Minimum clearance distances

Nominal Voltage (V)	Minimum clearance distance (mm)		
	Verified assemblies (*See* Note 2)		Non-verified assemblies
	Main switchboards	Other switchgear and ~~control gear~~ controlgear	Main switchboards and other switch and ~~control gear~~ controlgear
≤250 (*See* Note 1)	8	8	15
≤690 (*See* Note 1)	8	8	20
≤1000 (*See* Note 1)	8	8	25
<3 300	32	26	55
<6 600	60	50	90
<11 000	100	80	120
≤15 000	*See* Note 3	*See* Note 3	160

NOTES

1. For assemblies installed in spaces where the pollution degree is > 3, *see* ~~7.5.2~~ 5.7.2.
2. For the verification requirements for a verified assembly refer to IEC 61439-2.
3. Clearance distances with reference to the applicable relevant National or International Standards are to be submitted for approval, *see* ~~1.3.3~~ Ch 1, 1.5.3.

~~7.5.3~~ 5.7.3 For assemblies with a rated voltage above 1kV, the requirement of ~~7.5.1~~ 5.7.1 may be met by complying with IEC 60092-503: *Electrical installations in ships – Part 503: Special features – AC supply systems with voltages in the range of above 1 kV up to and including 15 kV*.

(a) Tables ~~1.7.1 and 1.7.2~~ 3.5.1 and 3.5.2 indicate the minimum clearance and creepage distances normally allowed.

(b) For main switchboards rated at above 1kV, a minimum clearance distance of 25 mm is required for busbars and other bare conductors.

(c) An alternative relevant National or International Standard may be used when an acceptable justification is submitted as part of the documentation required by ~~1.3.3~~ Ch 1, 1.5.3.

Table ~~1.7.2~~ 3.5.2 Minimum creepage distance

Nominal Voltage V	Minimum creepage distance (mm)	
	Main switchboards	Other switchgear and ~~control gear~~ controlgear
≤250 (*See* Note 1)	20	20
≤690 (*See* Note 1)	25	25
≤1000 (*See* Note 1)	35	35
<3 300	48	*See* Note 2
<6 600	90	70
<11 000	150	120
≤15 000	*See* Note 2	*See* Note 2

NOTES

1. For verified assemblies a minimum creepage distance of 16 mm is permitted for LV switchboards, *see* ~~7.5.2~~ 5.7.2.
2. Creepage distances, with reference to the applicable relevant National or International Standards, are to be submitted for approval, *see* ~~1.3.3~~ Ch 1, 1.5.3.

~~7.5.4~~ 5.7.4 Suitable shrouding or barriers are to be provided in way of connections to equipment, where necessary, to maintain the minimum distances in Table ~~1.7.1~~ 3.5.1.

~~7.6~~ 5.8 Degree of protections

Existing paragraph Pt 10, Ch 1, 7.6.1 *and* 7.6.2 *have been renumbered* Pt 9, Ch 3, 5.8.1 *and* 5.8.2.

~~7.6.2~~ 5.8.2 Where switchboards or section boards are required to comply with ~~5.2.2~~ 4.2.2, barriers are to be installed to provide protection for the independent sections against contamination due to the products of arcing, which may result in a fault.

5.8.3 Segregation between low-voltage and high-voltage circuits and equipment installed within common assemblies is to be in accordance with IEC 62271-1: *High-voltage switchgear and controlgear – Part 1: Common specifications*.

~~7.7~~ 5.9 Distribution boards

Existing paragraph Pt 10, Ch 1, 7.7.1 *has been renumbered* Pt 9, Ch 3, 5.9.1.

~~7.7.1~~ 5.9.1 Distribution boards are to be suitably enclosed unless they are installed in a cupboard or compartment to which only authorised persons have access in which case the cupboard may serve as an enclosure, *see* ~~7.16.4~~ 5.17.4.

~~7.8~~ 5.10 Earthing of high-voltage switchboards

Existing paragraphs Pt 10, Ch 1, 7.8.1 *and* 7.8.2 *have been renumbered* Pt 9, Ch 3, 5.10.1 *and* 5.10.2.

~~7.8.2~~ 5.10.2 Protective shutters associated with withdrawable parts are to be clearly marked~~, e.g., by colour coding,~~ to indicate the incoming and outgoing circuits and bus tie connections. The colour coding shall be as follows:

- Incoming (busbar side) – red;
- Outgoing (circuit side) – yellow; and
- Bus ties – red.

~~7.10~~ 5.11 Handrails or handles

Existing paragraph Pt 10, Ch 1, 7.10.1 *has been renumbered* Pt 9, Ch 3, 5.11.1.

~~7.11~~ 5.12 Instruments for alternating current generators

Existing paragraphs Pt 10, Ch 1, 7.11.1 *to* 7.11.5 *have been renumbered* Pt 9, Ch 3, 5.12.1 *to* 5.12.5.

~~7.11.3~~ 5.12.3 For parallel~~l~~ing purposes, two voltmeters, two frequency meters and two synchronising devices are to be provided. One voltmeter and one frequency meter are to be connected to the busbars, the other voltmeter and frequency meter are to be switched to enable the voltage and frequency of any generator to be measured. Where the electrical power requirement to maintain the ship in a normal operational and habitable condition is usually supplied by two or more generators operating in parallel, the two synchronising devices are to be independent of each other, *see also* ~~2.2.1~~ Ch 2, 4.2.1.

~~7.11.4~~ 5.12.4 The indicators and displays required by ~~7.11.1 to 7.11.3~~ 5.12.1 to 5.12.3 are to be located and arranged such that they are viewed at a single operating position. Where manual paralleling is provided, it is to be possible to adjust voltage and frequency at this position. Generators are to have controls to adjust their voltage and frequency located at the single operating position. Access to voltage adjustment is to be restricted, such that it will generally only be used by authorised personnel to avoid accidental operation.

Existing paragraph Pt 10, Ch 1, 7.11.5 *has been renumbered* Pt 9, Ch 3, 5.12.5.

~~7.12~~ 5.13 Instrument scales

Existing paragraphs Pt 10, Ch 1, 7.12.1 *to* 7.12.5 *have been renumbered* Pt 9, Ch 3, 5.13.1 *to* 5.13.5.

~~7.12.4~~ 5.13.4 Where the indications provided by the instrumentation required by ~~7.11~~ 5.12 are displayed digitally, nominal voltage, over voltage, over current and reverse power indications are to be indicated by an appropriate means. The information provided is to be clearly visible and immediately available.

~~7.12.5~~ 5.13.5 In general, indications provided by instrumentation which are displayed digitally are not to change more frequently than twice per second~~, or as agreed by the Naval Authority~~.

~~7.13~~ 5.14 Labels

Existing paragraph Pt 10, Ch 1, 7.13.1 *has been renumbered* Pt 9, Ch 3, 5.14.1.

~~7.14~~ 5.15 Protection

~~7.14.1~~ 5.15.1 *See* ~~Section 6~~ Chapter 4.

~~7.15~~ 5.16 Wiring

Existing paragraph Pt 10, Ch 1, 7.15.1 *has been renumbered* Pt 9, Ch 3, 5.16.1.

~~7.16~~ 5.17 Position of switchboards

Existing paragraph Pt 10, Ch 1, 7.16.1 to 7.16.5 *have been renumbered* Pt 9, Ch 3, 5.17.1 *to* 5.17.5.

~~7.16.1~~ 5.17.1 An unobstructed space not less than 1 m wide is to be provided in front of switchboards and section boards. When switchboards and section boards contain withdrawable equipment, the unobstructed space is to be not less than 0,4 m wide with this equipment in its fully withdrawn position.

~~7.16.3~~ 5.17.3 The spaces defined in ~~7.16.1~~ 5.17.1 and ~~7.16.2~~ 5.17.2 are to have non-slip surfaces. Where access to live parts within switchboards and section boards is normally possible the surface is, in addition, to be electrically insulated.

Existing paragraph Pt 10, Ch 1, 7.16.4 *has been renumbered* Pt 9, Ch 3, 5.17.4.

~~7.16.5~~ 5.17.5 For switchgear and ~~control gear~~ controlgear assemblies, for rated voltages above 1 kV, arrangements are to be made to protect personnel in the event of gases or vapours escaping under pressure as the result of arcing due to an internal fault. Where personnel may be in the vicinity of the equipment when it is energised, this may be achieved by an assembly that has been tested in accordance with Annex A of IEC 62271-200:2011:*High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV* and qualified for classification IAC (internal arc classification).

~~7.17~~ 5.18 Switchboard auxiliary power supplies

Existing paragraph Pt 10, Ch 1, 7.17.1 *has been renumbered* Pt 9, Ch 3, 5.18.1.

~~7.18~~ 5.19 Testing

Existing paragraphs Ch 1, 7.18.1 *and* 7.18.5 *have been renumbered* Pt 9, Ch 3, 5.19.1 *and* 5.19.5.

~~7.18.1~~ 5.19.1 Tests in accordance with ~~7.18.2 to 7.18.4~~ 5.19.2 to 5.19.4 are to be satisfactorily carried out on all assemblies, complete or in sections, at the manufacturer's premises, and a test report issued by the manufacturer, *see also* ~~1.4.2~~ Ch 1, 1.6.2.

~~7.18.2~~ 5.19.2 A high voltage test, *see* ~~Section 21~~ Ch 10, 1.

~~7.18.5~~ 5.19.5 For switchgear and ~~control gear~~ controlgear assemblies, for rated voltages above 1 kV, type tests are to be carried out, in accordance with Annex A of IEC 62271-200:2011: *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV* and IAC (internal arc classification) assigned, to verify that the assembly will withstand the effects of an internal arc occurring within the enclosure at a prospective fault level equal to, or in excess of, that of the installation.

Section ~~9~~ 6
Rotating machines – general requirements and motors

Existing paragraph Pt 10, Ch 1, Section 9.11 to 9.1.9 *have been renumbered* Pt 9, Ch 3, Section 6.1.1 to 6.1.9.

~~9.1~~ 6.1 General requirements

~~9.1.1~~ 6.1.1 Rotating machines are to comply with the relevant part of IEC 60092: *Electrical installations in ships*, or an acceptable and relevant National Standard, and the requirements of this Section. In addition, military aspects for shock are to be defined as required by Pt 1, Ch 2,4.9.

~~9.1.2~~ 6.1.2 For all the rotating machines a manufacturer's test certificate is to be provided, *see also* ~~9.8~~ 6.7.

Existing paragraph Pt 10, Ch 1, 9.1.3 *has been renumbered* Pt 9, Ch 3, 6.1.3.

~~9.1.4~~ 6.1.4 Shaft materials for rotating machines for essential services are to comply with the *Rules for Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials) and are to be manufactured under LR survey for the following applications:

(a) shaft material for dynamic positioning and electric propulsion motors; and
~~(b) shaft material for main engine driven generators where the shaft is part of the propulsion shafting; and~~
~~(c)~~(b) shaft material for machines with power ratings of 250 kW or greater.

Shaft material for machines with power ratings less than 250 kW is to have a manufacturer's certificate as detailed in Chapter 1 of the Rules for Materials.

Existing paragraph Pt 10, Ch 1, 9.1.5 *has been renumbered* Pt 9, Ch 3, 6.1.5.

~~9.1.6~~ 6.1.6 The rotating parts of machines are to be so balanced that when running at any speed in the normal working range the vibration does not exceed the levels of IEC 60034-14: *Rotating electrical machines – Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of vibration severity*.

~~9.1.7~~ 6.1.7 The lubrication arrangement for bearings is to be effective under all operating conditions including the maximum ship inclinations defined by ~~1.11~~ Table 2.4.2, Pt 1, Ch 2, 4.6 and there are to be effective means provided to ensure that lubricant does not reach the machine windings or other conductors and insulators.

Existing paragraphs Pt 10, Ch 1, 9.1.8 *and* 9.1.9 *have been renumbered* Pt 9, Ch 3, 6.1.8 *and* 6.1.9.

6.1.10 For high voltage machines, the stator insulation system is to be of a type that has undergone sample testing in accordance with the following International Standards, or relevant alternatives acceptable to LR, to demonstrate its suitability for the operating voltage in the presence of an LR Surveyor:

(a) IEC 60894, *Guide for a test procedure for the measurement of loss tangent of coils and bars for machine windings,* at the insulation class rated temperature; and
(b) IEC 60034-15, *Impulse Voltage Withstand Levels of Form-wound Stator Coils for Rotating a.c. Machines,* with power-frequency voltage withstand testing conducted.

Test samples are to be representative in terms of the number and size of conductors, coil construction, combination of materials and manufacturing process.

6.1.11 For testing required by 6.1.10 on coils relating to global vacuum pressure impregnated systems, test samples representing the unimpregnated state and the impregnated state of the final winding and stator core are to be used as appropriate for testing.

~~9.2~~ 6.2 ~~Rating~~ Ratings

~~9.2.1~~ 6.2.1 Generators, including their excitation systems, and continuously rated motors are to be suitable for continuous duty at their full rated output at maximum cooling air or water temperature for an unlimited period, without the limits of temperature rise in ~~9.3~~ 6.3 being exceeded. Other machines are to be rated in accordance with the duty which they have to perform and, when tested under rated load conditions, the temperature rise is not to exceed the values in ~~9.3~~ 6.3.

Existing paragraphs Pt 10, Ch 1, 9.2.1 *to* 9.2.3 *have been renumbered* Pt 9, Ch 3, 6.2.1 *to* 6.2.3.

~~9.3~~ 6.3 Temperature rise

Existing paragraphs Pt 10, Ch 1, 9.3.1 *to* 9.3.3 *have been renumbered* Pt 9, Ch 3, 6.3.1 *to* 6.3.3.

~~9.3.1~~ 6.3.1 The limits of temperature rise specified in Table ~~1.9.1~~ 3.6.1 are based on the cooling air temperature and cooling water temperature given in ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5.

~~9.3.2~~ 6.3.2 If it is known that the temperature of cooling medium exceeds the values given in ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5, the permissible temperature rise is to be reduced by an amount equal to the excess temperature of the cooling medium.

~~9.3.3~~ 6.3.3 If it is known that the temperature of cooling medium will be permanently less than the values given in ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5 the permissible temperature rise may be increased by an amount equal to the difference between the declared temperature and that given in ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5 up to a maximum of 15ºC.

~~9.5~~ 6.4 Overloads

Existing paragraph Volume 2, Part 10, Chapter 1, 9.5.1 *has been renumbered Volume* 2, Part 9, *Chapter* 3, 6.4.1

~~9.5.1~~ 6.4.1 ~~Machines~~ Motors are to withstand on test, without injury, the following momentary overloads~~:~~.

~~(a) Generators. An excess current of 50 per cent for 15 seconds after attaining the temperature rise corresponding to rated load, the terminal voltage being maintained as near the rated value as possible. The foregoing does not apply to the overload torque apacity of the prime mover.~~

~~(b) Motors.~~ At rated speed or, in the case of a range of speeds, at the highest and lowest speeds, under gradual increase of torque, the appropriate excess torque given below. Synchronous motors and synchronous induction motors are required to withstand the excess torque without falling out of synchronism and without adjustment of the excitation circuit preset at the value corresponding to rated load:

d.c. motors 50 per cent for 15 seconds;
polyphase a.c. synchronous
motors 50 per cent for 15 seconds;
polyphase a.c. synchronous
induction motors 35 per cent for 15 seconds;
polyphase a.c. induction
motors 60 per cent for 15 seconds.

~~(c) Propulsion machines. The overload tests for propulsion machines will be specially considered for each installation.~~

~~9.6~~ 6.5 Machine enclosure

Existing paragraph Volume 2, Part 10, Chapter 1, 9.5.1 *has been renumbered* Volume 2, Part 9, Chapter 3, 6.5.1.

~~9.5.1~~ 6.5.1 Where liquid-cooled heat exchangers are used in the machine cooling circuit there is to be provision to detect leakage of the liquid, and the system is to be arranged so as to prevent the entry of liquid into the machine.

~~9.7~~ 6.6 Direct current machines

Existing paragraph Pt 10, Ch 1, 9.7.1 *has been renumbered* Pt 9, Ch 3, 6.6.1.

~~9.7.1~~ 6.6.1 The final running position of brushgear ~~is not to give rise to excessive sparking and~~ is to be clearly and permanently marked.

6.6.2 Direct current machines are to work with fixed brush setting from no load to the momentary overload specified without injurious sparking.

~~9.8~~ 6.7 Survey and testing

Existing paragraphs Pt 10, Ch 1, 9.8.1 *to* 9.8.4 *have been renumbered* Pt 9, Ch 3, 6.7.1 *to* 6.7.3 *and* 6.7.6.

~~9.8.1~~ 6.7.1 On machines for essential services, tests are to be carried out and a certificate furnished by the manufacturer. The tests are to include temperature rise, momentary overload, high voltage, and commutation. The insulation resistance and the temperature at which it was measured are to be recorded, *see also* ~~1.4.2~~ Ch 1, 1.6.2.

~~9.8.2~~ 6.7.2 In the case of duplicate machines, type tests of temperature rise, excess current and torque and commutation taken on a machine identical in rating and in all other essential details may be accepted in conjunction with abbreviated tests on each machine. Type tests for propulsion machines will be specially considered, *see also* ~~Section 16~~ Pt 4, Ch 5. For the abbreviated tests, each machine is to be run and is to be found electrically and mechanically sound and is to have a high voltage test and insulation resistance recorded.

~~9.8.3~~ 6.7.3 A high voltage test, in accordance with ~~Section 21~~ Ch 10, Section 1, is to be applied to new machines, preferably at the conclusion of the temperature rise test. Where both ends of each phase are brought out to accessible separate terminals, each phase is to be tested separately.

6.7.4 Survey during manufacture, *see* 1.4, is to be conducted prior to testing of the completed machine and is to include inspection of rotor and stator assemblies to assess compliance with the constructional requirements of the relevant standards and this Section.

6.7.5 For high voltage machines, a description of rotor and stator insulation system application procedures (taping, impregnation, pressing and curing, etc.) with application process records, including details of checks and tests conducted to verify successful application, is to be made available to the LR Surveyor during manufacture, *see also* 6.1.14.

~~9.8.4~~ 6.7.6 ~~An~~ Routine impulse ~~test is~~ tests are to be carried out on the coils of high voltage machines in accordance with IEC 60034-15: *Rotating electrical machines – Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines,* in order to demonstrate a satisfactory withstand level of the inter-turn insulation to voltage surges.

The test is to be carried out on all coils after they have been inserted in the slots and after wedging and bracing. Each coil shall be subjected to at least five impulses of injected voltage, the peak value of the injected voltage being given by the formula:

V peak = 2,45V
where
V = rated line voltage r.m.s.

Alternative proposals to demonstrate the withstand level of interturn insulation will be considered.

■ *Section ~~10~~ 7*
Converter equipment

Existing paragraphs Pt 10, Ch1,10.1.1 *to* 10.1.13 *have been renumbered* Pt 9, Ch 3, 7.1.1 *to* 7.1.13.

~~10.1~~ 7.1 Transformers

~~10.1.1~~ 7.1.1 Paragraphs ~~10.1.2 to 10.1.13~~ 7.1.2 to 7.1.13 apply to transformers rated for 5 kVA upwards.

~~10.1.2~~ 7.1.2 Transformers are to comply with the requirements of ~~IEC 60076 Power transformers or an acceptable and relevant National Standard amended where necessary for ambient temperature, see 1.10.~~ the following standards as appropriate:

(a) IEC 60076 (all parts): *Power transformers*
(b) IEC 60092-503: *Electrical installations in ships – Part 503: Special features – AC supply systems with voltages in the range of above 1 kV up to and including 15 kV*; or
(c) an acceptable and relevant National Standard amended where necessary for ambient temperature, *see* Table 2.4.1, Pt 1, Ch 2,4.5.

Existing paragraph Pt 10 Ch1,10.1.3 *has been renumbered* Pt 9, Ch 3, 7.1.3.

~~10.1.4~~ 7.1.4 The temperature rise of the winding of transformers above the ambient temperatures given in ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5, when measured by resistance during continuous operation at the maximum rating, is not to exceed:

(a) For dry type transformers, air cooled:
    insulation of Class A – 50ºC
    insulation of Class E – 60ºC
    insulation of Class B – 70ºC
    insulation of Class F – 90ºC
    insulation of Class H – 110ºC
(b) For liquid filled transformers:
    50ºC – where air provides cooling of the fluid
    65ºC – where water provides cooling of the fluid.

Existing paragraph Pt 10, Ch1,10.1.5 *has been renumbered* Pt 9, Ch 3, 7.1.5.

~~10.1.6~~ 7.1.6 The inherent regulation of transformers at their rated output is to be such that the total percentage voltage drop to any point in the installation does not exceed that allowed by ~~1.8.2(a)~~ Ch 1, 2.1.2 (a).

Existing paragraphs Pt 10, Ch1,10.1.7 to 10.1.10 *have been renumbered* Pt 9, Ch 3, 7.1.7 *to* 7.1.10.

~~10.1.11~~ 7.1.11 Transformers for propulsion power are to be provided with arrangements such that, in the event of excessive winding temperature, an alarm is initiated and:

- the load is reduced to a level commensurate with the cooling arrangements; or
- automatic ~~shut-down~~ shutdown of the transformer occurs.

Existing paragraph Pt 10, Ch1,10.1.12 *has been renumbered* Pt 9, Ch 3, 7.1.12.

~~10.1.13~~ 7.1.13 The following tests are to be carried out on all transformers at the manufacturer's works, and a certificate of tests is to be issued by the manufacturer, *see also* ~~1.4.2 and 1.4.3~~ Ch 1, 1.6.2 and 1.6.3:

(a) measurement of winding resistances, voltage ratio, impedance voltage, short-circuit impedance, insulation resistance, load loss, no load loss and current;
(b) dielectric tests; ~~and~~
(c) temperature rise test on one transformer of each size and type; and
(d) where evidence of compliance with ~~10.1.9~~ 7.1.9 is not submitted for consideration, short-circuit withstand on one transformer of each size and type.

~~10.2~~ 7.2 Semiconductor ~~equipment~~ converters

Existing paragraphs Pt 10, Ch 1,10.2.1 *to* 10.2.18 *have been renumbered* Pt 9, Ch 3, 7.2.1 *to* 7.2.18.

~~10.2.1~~ 7.2.1 The requirements of ~~10.2.2 to 10.2.17~~ 7.2.2 to 7.2.17 apply to semiconductor ~~equipment~~ converters rated for 5 kW upwards.

~~10.2.2~~ 7.2.2 Semiconductor ~~equipment is~~ converters are to comply with the requirements of IEC 60146: *Semiconductor converters* (all parts), or an acceptable and relevant National Standard amended where necessary for ambient temperature, *see* ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5.

~~10.2.3~~ 7.2.3 Semiconductor static power converters ~~equipment is~~ are to be rated for the required duty having regard to peak loads, system transients and overvoltage.

~~10.2.11~~7.2.11 Converter equipment, including any associated transformers, reactors, capacitors and filters, if provided, is to be so arranged that the harmonic distortion, and voltage spikes, introduced into the ship's electrical system are within the limits of ~~1.8.3~~ Ch 1, 2.1.3 or restricted to a lower level necessary to ensure that it causes no malfunction of equipment connected to the electrical installation. Converter equipment cables may carry high frequency currents that can cause interference. These cables are to be kept as short as possible and installed as far away as possible from sensitive signal cables.

Table ~~1.9.1~~ 3.6.1 Limits of temperature rise of machines cooled by air

Limits of temperature rise of machines cooled by air, °C						
Part of machine	Method of temperature measurement	Insulation class				
		A	E	B	F	H
1. (a) a.c. windings of machines having output of 5000 kVA or more	ETD R	55 50	– –	75 70	95 90	115 110
(b) a.c. windings of machines having output of less than 5000 kVA	ETD R	55 50	– 65	80 70	100 95	115 110
2. Windings of armatures having commutators	R T	50 40	65 55	70 60	95 75	115 95
3. Field windings of a.c. and d.c. machines having d.c. excitation other than those in item 4	R T	50 40	65 55	70 60	95 75	115 95
4. (a) Field windings of synchronous machines with cylindrical rotors having d.c. excitation	R	–	–	80	100	125
(b) Stationary field windings of d.c. machines having more than one layer	R T	50 40	65 55	70 60	95 75	115 95
(c) Low resistance field windings of a.c. and d.c. machine and compensating windings of d.c. machines having more than one layer	R, T	50	65	70	90	115
(d) Single-layer windings of a.c. and d.c. machines with exposed, bare or varnished metal surfaces and single-layer compensating windings of d.c. machines	R, T	55	70	80	100	125
5. Permanently short-circuited insulated windings	T	50	65	70	90	115
6. Permanently short-circuited uninsulated windings	T	The temperature rise of these parts shall in no case reach such a value that there is a risk to any insulation or other materials on adjacent parts or to the item itself				
7. Magnetic cores and other parts not in contact with windings						
8. Magnetic cores and other parts in contact with windings	T	50	65	70	90	110
9. Commutators and slip-rings open and enclosed	T	50	60	70	80	90

NOTES

1. Where water cooled heat exchangers are used in the machine cooling circuit, the temperature rises are to be measured with respect to the temperature of the cooling water at the inlet to the heat exchanger and the temperature rises given in Table ~~1.8.1~~ 3.6.1 shall be increased by 10°C provided the inlet water temperature does not exceed the values given in ~~1.10~~ Table 2.4.1, Pt 1, Ch 2, 4.5.
2. T = thermometer method
   R = resistance method
   ETD = embedded temperature detector
3. Temperature rise measurements are to use the resistance method whenever practicable.
4. The ETD method may only be used when the ETDs are located between coil sides in the slot.

Existing paragraphs Pt 10, Ch1,10.2.12 *to* 10.2.15 *have been renumbered* Pt 9, Ch 3, 7.2.12 *to* 7.2.15.

~~10.2.16~~ 7.2.16 Any regenerated power developed during the operation of converter equipment is not to result in disturbances to the supply system voltage and frequency which exceeds the limits of ~~1.8~~ Ch 1, 2.1.

Existing paragraph Pt 10, Ch1,10.2.17 *has been renumbered* Pt 9, Ch 3, 7.2.17.

~~10.2.18~~ 7.2.18 Tests at the manufacturer's works of converter equipment and any associated reactors or filters are to include the high voltage test of ~~21.1~~ Ch 10, 1.1, a temperature rise test on one of each size and type of converter equipment, and such other tests as may be necessary to demonstrate the suitability of the equipment for its intended duty. Details of tests are to be submitted for consideration when required, *see also* ~~1.4.2~~ Ch 1, 1.6.2.

~~10.3~~ 7.3 Uninterruptible power systems

Existing paragraphs Pt 10, Ch1,10.3.1 *to* 10.3.13 *have been renumbered* Pt 9, Ch 3, 7.3.1 *to* 7.3.13.

~~10.3.1~~ 7.3.1 The requirements of this sub-Section apply to all uninterruptible power systems (UPS) intended to maintain essential services or provide emergency services. This sub-Section is in addition to the requirements of ~~10.1~~ 7.1 to ~~10.2~~ 7.2 and ~~Section 12~~ Ch 2, Section 7, as applicable.

~~*10.3.2*~~ *7.3.2* UPS units are to be constructed in accordance with IEC 62040: *Uninterruptible power systems (UPS)(all parts)*, or an acceptable and relevant National or International Standard.

~~*10.3.8*~~ *7.3.8* UPS units utilising valve-regulated sealed batteries may be located in compartments with standard marine or industrial electrical equipment provided that the arrangements comply with ~~12.3.5~~ Ch 2, 7.3.5. Ventilation arrangements in accordance with IEC 62040-1: *Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS*, or an acceptable and relevant National or International Standard, may be considered to satisfy the requirements of ~~12.5.10~~ Ch 2, 7.5.10.

Existing paragraph Pt 10, Ch1,10.3.9 *has been renumbered* Pt 9, Ch 3, 7.3.9.

~~*10.3.10*~~ *7.3.10* The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified. Where it is proposed that additional circuits are connected to the UPS unit, details verifying that the UPS unit has adequate capacity are to be submitted for consideration, *see* ~~1.5~~ Ch 1, 1.7.

Existing paragraph Pt 10, Ch1,10.3.11 *has been renumbered* Pt 9, Ch 3, 7.3.11.

~~*10.3.12*~~ *7.3.12* Tests at the manufacturer's works or after installation on board are to include such tests necessary to demonstrate to the Surveyor's satisfaction the suitability of the UPS unit for its intended duty and location. As a minimum, the following tests are required:

- a temperature rise test;
- battery capacity test;
- a ventilation rate test of both the equipment housing and the space into which it is to be located, *see also* ~~12.5~~ Ch 2, 7.5; and
- functional testing, including operation of alarms.

Details of tests are to be submitted for consideration when required, *see also* ~~1.4.2~~ Ch 1, 1.6.2.

Existing paragraph Pt 10, Ch1,10.3.13 *has been renumbered* Pt 9, Ch 3, 7.3.13.

■ *Section ~~11~~ 8*
Electric cables, optical fibre cables and busbar trunking systems (busways)

Existing paragraphs Pt 10, Ch 1, 11.1.1 *to* 11.1.8 *have been renumbered* Pt 9, Ch 3, 8.1.1 *to* 8.1.8.

~~11.1~~ 8.1 General

~~*11.1.1*~~ *8.1.1* The requirements of ~~11.1 to 11.15~~ 8.1 to 8.16 apply to all electric cables for fixed wiring unless otherwise exempted. The requirements of ~~11.17~~ 8.17.1 to 8.17.6 apply to busbar trunking systems (busways) where they are used in place of electric cables.

Table ~~1.11.1~~ 3.8.1 Electric cables

Application	IEC Standard	Title
General constructional and testing requirements	60092–350	~~Low-voltage shipboard power cables. General construction and test requirements~~ Electrical installations in ships – Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications
Fixed power and control circuits	60092–353	~~Single and multicore non-radial field power cables with extruded solid insulation for rated voltages 1 kV and 3 kV~~ Electrical installations in ships – Part 353: Power cables for rated voltages 1 kV and 3 kV
Fixed power circuits	60092–354	~~Single and three-core power cables with extruded solid insulation for rated voltages 6 kV, 10 kV and 15 kV~~ Electrical installations in ships – Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
Instrumentation, control and communication circuits up to 60 V	60092-370	Electrical installations in ships – Part 370: Guidance on the selection of cables for telecommunication and data transfer including radio-frequency cables
Control and instrumentation circuits up to 250 V	60092–376	~~Cables for control and instrumentation circuits~~ Electrical installations in ships – Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)
Mineral insulated	60702 (all parts)	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V

~~*11.1.2*~~ *8.1.2* Electric cables for fixed wiring are to be designed, manufactured and tested in accordance with the ~~relevant~~ IEC Standards specified in Table ~~1.11.1~~ 3.8.1or a ~~relevant~~ specified standard acceptable to the ~~Naval Authority~~ Naval Administration. On application, LR may be able to assess the acceptability of cables in accordance with specified standards other than the relevant IEC Standards ~~on behalf of the Naval Authority~~, *see also* ~~1.1.6~~ Ch 1, 1.2.4.

Existing paragraph Pt 10, Ch 1, 11.1.3 *has been renumbered* Pt 9, Ch 3, 8.1.3.

~~11.1.4~~ 8.1.4 Surveys of cables for electric propulsion systems during manufacture and testing, *see* ~~1.4.3~~ Ch 1, 1.6.3, are to assess compliance with the applicable International, National or Naval Standards and the application of an acceptable quality management system.

~~11.1.5~~ 8.1.5 Where increased flexibility is required due to confines of space, cables having Class 5 stranded conductors in accordance with IEC 60228: *Conductors of insulated cables* may be accepted provided ~~11.1.2~~ 8.1.2 is otherwise complied with. Provided that the adequate flexibility of the finished cable is assured, conductors of nominal cross-sectional area 2,5 mm^2 and less need not be stranded.

Existing paragraphs Pt 10, Ch 1, 11.1.6 *to* 11.1.8 *have been renumbered* Pt 9, Ch 3, 8.1.6 *to* 8.1.8.

~~11.2~~ 8.2 Testing

Existing paragraph Pt 10, Ch 1, 11.2.1 and 11.2.2 *has been renumbered* Pt 9, Ch 3, 8.2.1 and 8.2.2.

~~11.2.1~~ 8.2.1 Routine tests, consisting of at least:

(a) measurement of electrical resistance of conductors;
(b) high voltage test, *see also* ~~Section 21~~ Ch 10, Section 1;
(c) insulation resistance measurement;
(d) for high voltage cables, partial discharge tests are to be made in accordance with the requirements of IEC 60885-2~~,~~: *Electrical test methods for electric cables~~.~~ – Part 2: Partial discharge tests*, or ~~an acceptable~~ a relevant National Standard, at the manufacturer's works prior to despatch.

Evidence of successful completion of routine tests is to be provided by the manufacturer, *see also* ~~1.4.3~~ Ch 1, 1.6.3.

~~11.2.2~~ 8.2.2 Particular, special and type tests are to be made, when required, in accordance with the requirements of the relevant publication or National Standard referred to in ~~11.1.2~~ 8.1.2, and a test report issued by the manufacturer.

~~11.3~~ 8.3 Voltage rating

Existing paragraph Pt 10, Ch 1, 11.3.1 *and* 11.3.2 *have been renumbered* Pt 9, Ch 3, 8.3.1 *and* 8.3.2

~~11.4~~ 8.4 Operating temperature

Existing paragraph Pt 10, Ch 1, 11.4.1 *to* 11.4.3 *have been renumbered* Pt 9, Ch 3, 8.4.1 *to* 8.4.3.

~~11.4.2~~ 8.4.2 The maximum rated conductor temperatures for normal and short-circuit operation, for the insulating materials included within the standards referred to in ~~11.1.2~~ 8.1.2 are not to exceed the values stated in Table ~~1.11.2~~ 3.8.2.

(*Part only shown*)

Table ~~1.11.2~~ 3.8.2 Maximum rated conductor temperature

~~11.4.3~~ 8.4.3 Electric cables constructed of an insulating material not included in Table ~~1.11.2~~ 3.8.2 are to be rated in accordance with the National Standard chosen in compliance with ~~11.1.2~~ 8.1.2.

~~11.5~~ 8.5 Construction

Existing paragraphs Volume 2, Part 10, Chapter 1, 11.5.1 *to* 11.5.10 *have been renumbered* Volume 2, Part 9, Chapter 3, 8.5.1 *to* 8.5.10.

~~11.5.1~~ 8.5.1 Electric and optical fibre cables are to be at least of a flame-retardant, low smoke, halogen free type. Compliance with IEC 60332-1-2: *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1kW pre-mixed flame*, IEC 61034: *Measurements of smoke density of electric cables burning under defined conditions*, IEC 60754: *Tests on gases evolved during combustion of materials from cables* will be acceptable. Where cables are installed in bunches, the requirements of ~~11.8.10~~ 8.8.10 are to be satisfied. Alternative proposals for equipment cabling that demonstrate satisfactory smoke and toxicity performance under fire conditions for identified areas of a ship may be submitted for consideration ~~where requested by the Naval Authority~~.

~~11.5.2~~ 8.5.2 Exemption from the requirements of ~~11.5.1~~ 8.5.1 for applications such as radio frequency or digital communication systems, which require the use of particular types of cable, will be subject to special consideration.

~~11.5.3~~ 8.5.3 Where electric or optical fibre cables are required to be of a 'fire-resistant type', they are in addition to be easily distinguishable and comply with the performance requirements of the appropriate part of IEC 60331: *Tests for electric cables under fire conditions - Circuit integrity*, when tested with a minimum flame application time of 90 minutes, as follows:
IEC 60331-1: *Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*;
IEC 60331-21: *Tests for electric cables under fire conditions – Circuit integrity – Part 21: Procedures and requirements - Cables of rated voltage up to and including 0, 6/1, 0kV*;
IEC 60331-23: *Tests for electric cables under fire conditions – Circuit integrity – Part 23: Procedures and requirements - Electric data cables*; or
IEC 60331-25: *Tests for electric cables under fire conditions – Circuit integrity – Part 25: Procedures and requirements - Optical fibre cables*.

Existing paragraphs Pt 10, Ch 1, 11.5.4 *and* 11.5.5 *have been renumbered* Pt 9, Ch 3, 8.5.4 *and* 8.5.5.

~~11.5.6~~ 8.5.6 Where it is required that the construction of electrical or optical fibre cables includes metallic sheaths, armouring or braids, they are to be provided with an overall impervious sheath or other means to protect the metallic elements against corrosion, *see also* ~~11.8.7 and 11.8.8~~ 8.8.7 and 8.8.8.

Existing paragraph Pt 10, Ch 1, 11.5.7 *has been renumbered* Pt 9, Ch 3, 8.5.7.

~~11.5.8~~ 8.5.8 Where single core electric cables are used in circuits rated in excess of 20 Amps and are armoured, the armour is to be of a non-magnetic material.

Existing Pt 10, Ch 1, 11.5.9 *and* 11.5.10 *have been renumbered* Pt 9, Ch 3, 8.5.9 *and* 8.5.10.

Existing paragraph Pt 10, Ch 1, 11.6 *has been renumbered* Pt 9, Ch 3, 8.6.

~~11.6~~ 8.6 Conductor size

~~11.6.1~~ 8.6.1 The maximum continuous load carried by a cable is not to exceed its continuous current rating. It is to be chosen such that the maximum rated conductor temperature for normal operation for the insulation is not exceeded. In assessing the current rating the correction factors in ~~11.7~~ 8.7 may be applied as required.

Existing paragraph Pt 10, Ch 1, 11.6.1 *to* 11.6.6 *have been renumbered* Pt 9, Ch 3, 8.6.1 *to* 8.6.2.

~~11.6.3~~ 8.6.3 The cable current ratings given in Tables ~~1.11.3~~ 3.8.3 and ~~1.11.4~~ 3.8.4 are based on the maximum rated conductor temperatures given in Table ~~1.11.2~~ 3.8.2. When cable sizes are selected on the basis of precise evaluation of current rating based upon experimental and calculated data, details are to be submitted for consideration. Alternative short-circuit temperature limits, other than those given in Table ~~1.11.4~~ 3.8.4, may be applied using the data provided in:

- IEC 60724:*Short-circuit temperature limits of electric cables with rated voltages of 1kV (Um=1,2kV) and 3kV (Um=3,6kV)*;or
- IEC 60986: *Short-circuit temperature limits of electric cables with rated voltages from 6kV (Um=7,2kV) and up to 30kV (Um=36kV)*.

Alternative short-circuit temperature limits provided in an acceptable and relevant National Standard may also be considered.

(*Part only shown*)

Table ~~1.11.3~~ 3.8.3 Electric cable current ratings, normal operation, based on ambient 45°C

Table ~~1.11.4~~ 3.8.4 Electric cable current ratings, r.m.s. short-circuit current

Nominal cross-section (mm^2)	Fault current (kA) at 150°C		
	1s duration	0,5s duration	0,1s duration
200	21,8	30,9	69~~.~~, 0
240	26,2	37,0	82~~.~~, 8

~~11.6.4~~ 8.6.4 The cross-sectional area of the conductors is to be sufficient to ensure that at no point in the installation will the voltage variations stated in ~~1.8~~ Ch 1, 2.1 be exceeded when the conductors are carrying the maximum current under their normal conditions of service.

~~11.6.5~~ 8.6.5 The size of earth conductors is to comply with ~~1.13.7~~ Ch 1, 2.4.7.

~~11.6.6~~ 8.6.6 The cross-sectional area of conductors used in circuits supplying cyclic or non-continuous loads is to be sufficient to ensure that the cables maximum rated conductor temperature for normal operation is not exceeded when the conductors are operating under their normal conditions of service, *see* ~~11.7.4~~ 8.7.4.

~~11.7~~ 8.7 Correction factors for cable current rating

Existing paragraph Pt 10, Ch 1, 11.7.1 *to* 11.7.5 *have been renumbered* Pt 9, Ch 3, 8.7.1 *to* 8.7.5.

~~11.7.1~~ 8.7.1 The correction factors of ~~11.7.2 to 11.7.5~~ 8.7.2 to 8.7.5 provide a guide for general applications in assessing a current rating. A more precise evaluation based upon experimental and calculated data may be submitted for consideration.

Existing paragraph Pt 10, Ch 1, 11.7.2 *has been renumbered* Pt 9, Ch 3, 8.7.2.

~~11.7.3~~ 8.7.3 **Ambient temperature**. The current ratings of Table ~~1.11.3~~ 3.8.3 are based on an ambient temperature of 45°C. For other values of ambient temperature the correction factors shown in Table ~~1.11.5~~ 3.8.5 are to be applied.

Existing paragraph Pt 10, Ch 1, 11.7.4 *has been renumbered* Pt 9, Ch 3, 8.7.4

Table ~~1.11.5~~ 3.8.5 Correction factors

~~11.7.5~~ 8.7.5 **Diversity**. Where cables are used to supply two or more final sub-circuits, account may be taken of any diversity factors which may apply, *see* ~~5.6~~ 4.6.

~~11.8~~ 8.8 Installation of electric cables

Existing paragraph Pt 10, Ch 1, 11.8.1 *to* 11.8.22 *have been renumbered* Pt 9, Ch 3, 8.8.1 *to* 8.8.22.

~~11.8.2~~ 8.8.2 Bends in fixed electric and optical fibre cable runs are to be in accordance with the cable manufacturer's recommendations. The minimum internal radius of bend for the installation of fixed electric cables is to be chosen according to the construction and size of the cable and is not to be less than the values given in Table ~~1.11.6~~ 3.8.6.

Table ~~1.11.6~~ 3.8.6 Minimum internal radii of bends in cables for fixed wiring

Existing paragraphs Pt 10, Ch 1, 11.8.3 *and* 11.8.4 *have been renumbered* Pt 9, Ch 3, 8.8.3 *and* 8.8.4.

~~11.8.5~~ 8.8.5 Electric and optical fibre cables having insulating materials with different maximum rated conductor temperatures are to be so installed that the maximum rated conductor temperature for normal operation of each cable is not exceeded.

Existing paragraphs Pt 10, Ch 1, 11.8.6 *to* 11.8.9 *have been renumbered* Pt 9, Ch 3, 8.8.6 *to* 8.8.9.

~~11.8.10~~ 8.8.10 Where ~~electric and optical fibre~~ cables are installed in bunches, provision is to be made to limit the propagation of fire. This requirement is considered satisfied when cables of the bunch have been tested in accordance with the requirements of IEC 60332-3-22:*Tests on electric and optical fibre cables under fire conditions, Part 3-22, Test for vertical flame spread of vertically mounted bunched wires or cables - Category A*, provided that, in addition, there is no shedding of flaming droplets of sheath or insulation material and that they are installed to the same configuration(s) as used in the test(s). If the cables are not so installed, information is to be submitted to demonstrate satisfactorily that suitable measures are taken to ensure that an equivalent limit of fire propagation will be achieved for the configuration(s) used. Particular attention is to be given to cables in vertical runs in trunks and other restricted spaces. In addition, cables that comply with the requirements of IEC 60332-3-22 are also required to meet the requirements of IEC 60332-1-2: *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*.

Existing paragraphs Pt 10, Ch 1, 11.8.11 *and* 11.8.12 *have been renumbered* Pt 9, Ch 3, 8.8.11 *and* 8.8.12.

~~11.8.13~~ 8.8.13 All metal coverings of electric and optical fibre cables are to be earthed in accordance with ~~1.12~~ Ch 1, 2.4.

Existing paragraphs Pt 10, Ch 1, 11.8.14 *and* 11.8.15 *have been renumbered* Pt 9, Ch 3, 8.8.14 *and* 8.8.15.

~~11.8.16~~ 8.8.16 High-voltage electric cables are to be segregated ~~as far as is practicable~~ from electric cables operating at lower voltages.

~~11.8.17~~ 8.8.17 Electric and optical fibre cables are to be, so far as reasonably practicable, installed remote from sources of mechanical damage. Where necessary, the cables are to be protected in accordance with the requirements of ~~11.9~~ 8.9.

~~11.8.18~~ 8.8.18 Electric and optical fibre cables, with the exception of those for portable appliances and those installed in protective casings, are to be fixed securely in accordance with the requirements of ~~11.10~~ 8.10.

Existing paragraph Pt 10, Ch 1, 11.8.19 *has been renumbered* Pt 9, Ch 3, 8.8.19.

~~11.8.20~~ 8.8.20 Where electric and optical fibre cables penetrate bulkheads and decks, the requirements of ~~11.11~~ 8.11 are to be complied with.

~~11.8.21~~ 8.8.21 Where electric and optical fibre cables are installed in protective casings, the requirements of ~~11.12~~ 8.12 are to be complied with.

~~11.8.22~~ 8.8.22 a.c. wiring is to be carried out using multicore cables wherever reasonably practicable. Where it is necessary to install single core electric cables for alternating current circuits in excess of 20 Amps the requirements of ~~11.14~~ 8.14 are to be complied with. *See also* ~~11.5.8~~ 8.5.8.

~~11.9~~ 8.9 Mechanical protection of cables

Existing paragraphs Volume 2, Part 10, Chapter 1, 11.9.1 *to* 11.9.3 *have been renumbered* Volume 2, Part 9, Chapter 3, 8.9.1 *to* 8.9.3

~~11.9.1~~ 8.9.1 Electric or optical fibre cables exposed to risk of mechanical damage are to be protected by suitable protective casings unless the protective covering (e.g., armour or sheath) is sufficient to withstand the possible cause of damage.

~~11.9.2~~ 8.9.2 Electric or optical fibre cables installed in spaces where there is exceptional risk of mechanical damage such as hangers, storage spaces, etc., are to be suitably protected by metallic protective casings, even when armoured, unless the ship's structure affords adequate protection.

~~11.9.3~~ 8.9.3 Metal protective casings are to be efficiently protected against corrosion, and effectively earthed in accordance with ~~1.12~~ Ch 1, 2.4.

~~11.10~~ 8.10 Cable support systems

Existing paragraphs Volume 2, Part 10, Chapter 1, 11.10.1 *to* 11.10.5 *have been renumbered* Volume 2, Part 9, Chapter 3, 8.10.1 *to* 8.10.5.

~~11.10.1~~ 8.10.1 Electric cables are to be effectively supported and secured, without being damaged, to the ships' structure, either indirectly by a cable support system, or directly by means of clips, saddles or straps to bulkheads etc., *see* ~~11.8.4~~ 8.8.4.

Existing paragraph Pt 10, Ch 1, 11.10.2 *has been renumbered* Pt 9, Ch 3, 8.10.2.

~~11.10.3~~ 8.10.3 The distances between the points at which the cable is supported (e.g., distances between ladder rungs, support brackets, hangers, etc.) are to be chosen according to the construction of cable (i.e., size and rigidity) and the probability of vibration and are to be generally in accordance with those given in Table ~~1.11.7~~ 3.8.7.

Table ~~1.11.7~~ 3.8.7 Maximum spacing of supports or fixings for securing cables

~~*11.10.4*~~ *8.10.4* Where the cables are laid on top of their support system, the spacing of the clips, straps, etc. securing the cables may be increased beyond the spacing given in Table ~~1.11.7~~ 3.8.7, but should take account of movement and vibration and in general is not to exceed 900 mm. This relaxation is not to be applied where cables can be subjected to heavy external forces, e.g., where they are run on, or above, open deck or in areas subject to sea-water impingement.

Existing paragraph Pt 10, Ch 1, 11.10.5 *has been renumbered* Pt 9, Ch 3, 8.10.5.

Existing paragraphs Pt 10, 1.15.3 *and* 1.15.4 *have been renumbered* Pt 9, Ch 3, 8.10.6 *and* 8.10.7.

~~*1.15.3*~~ *8.10.6* Cables for emergency alarms and their power sources are to be in accordance with ~~1.18~~ Ch 1, 2.5.

~~*1.15.4*~~ *8.10.7* Electrical equipment and cables for emergency alarms are to be so arranged that the loss of alarms in any one area due to localised fire, collision, flooding or similar damage is minimised, *see* ~~1.16 to 1.18~~ Ch 1, 2.5 and Ch 1, 2.6.

~~11.11~~ 8.11 Penetration of bulkheads and decks by cables

Existing paragraphs Pt 10, Ch 1, 11.11.1 *to* 11.11.4 *have been renumbered* Pt 9, Ch 3, 8.11.1 *to* 8.11.4.

~~11.12~~ 8.12 Installation of electric and optical fibre cables in protective casings

Existing paragraphs Pt 10, Ch 1, 11.12.1 *to* 11.12.7 *have been renumbered* Pt 9, Ch 3, 8.12.1 *and* 8.12.7.

~~*11.12.3*~~ *8.12.3* The internal radius of bends of protective casings are to be not less than that required for the largest cable installed therein, *see* ~~11.8.2~~ 8.8.2.

Existing paragraphs Pt 10, Ch 1, 11.12.4 *to* 11.12.7 *have been renumbered* Pt 9, Ch 3, 8.12.4 *to* 8.12.7.

~~11.13~~ 8.13 Non-metallic cable support systems, protective casings and fixings

Existing paragraph Pt 10, Ch 1, 11.3 *has been renumbered* Pt 9, Ch 3, 8.13

~~*11.13.1*~~ *8.13.1* Where it is proposed to use non-metallic cable support systems, protective casings or fixings, the additional requirements of this sub-Section apply. Non-metallic protective cases are not permitted where ~~11.8.14(b)~~ 8.8.14 (b) applies.

Existing paragraphs Pt 10, Ch 1, 11.3.1 *to* 11.3.7 *have been renumbered* Pt 9, Ch 3, 8.13.1 *to* 8.13.7.

~~*11.13.7*~~ *8.13.7* Non-metallic fixings are to be flame retardant in accordance with the requirements of IEC 60092-101~~,~~: *Electrical installations in ships – Part 101: Definitions and general requirements*, or an alternative, relevant National or International Standard.

~~11.14~~ 8.14 Single core electric cables for alternating current

Existing paragraphs Pt 10, Ch 1, 11.14.1 *to* 11.14.6 *have been renumbered* Pt 9, Ch 3, 8.14.1 *to* 8.14.6.

~~11.15~~ 8.15 Electric cable ends

Existing paragraph Pt 10, Ch 1, 11.15 *has been renumbered* Pt 9, Ch 3, 8.15.

~~*11.15.1*~~ *8.15.1* Where screw-clamp or spring-clamp type terminations are used in electrical apparatus for external cable connections (*see* ~~1.12.7~~ Ch 1, 2.2.12), cable conductors of the solid or stranded type may be inserted directly into the terminals. Where flexible conductors are used, a suitable termination is to be fitted to the cable conductor to prevent ‘whiskering’ of the strands.

Existing paragraph Pt 10, Ch 1, 11.15.2 *has been renumbered* Pt 9, Ch 3, 8.15.2.

~~*11.15.3*~~ *8.15.3* Soldered sockets may be used in conjunction with non-corrosive fluxes provided that the maximum conductor temperature at the joint, under short-circuit conditions, does not exceed 160ºC.

Existing paragraphs Pt 10, Ch 1, 11.15.1 *to* 11.15.8 *have been renumbered* Pt 9, Ch 3, 8.15.1 *to* 8.15.8.

~~11.16~~ 8.16 Joints and branch circuits in cable systems

Existing paragraphs Pt 10, Ch 1, 11.16.1 *to* 11.16.4 *have been renumbered* Pt 9, Ch 3, 8.16.1 *to* 8.16.4.

~~*11.16.1*~~ *8.16.1* If a joint is necessary it is to be carried out so that all conductors or fibres are adequately secured, insulated and protected from atmospheric action. The flame retardant properties or fire-resisting properties of the cable are to be retained, the continuity of metallic sheath, braid or armour is to be maintained and the current-carrying capacity or transmission of data through the cable is not to be impaired.

~~*11.16.4*~~ *8.16.4* Cables of a fire-resistant type (*see* ~~11.5.3~~ 8.5.3) are to be installed so that they are continuous throughout their length without any joints or tappings.

~~11.17~~ 8.17 Busbar trunking systems (bustrunks)

Existing paragraph Pt 10, Ch 1, 11.17 *has been renumbered* Pt 9, Ch 3, 8.17.

~~*11.17.1*~~ *8.17.1* Where busbar trunking systems are used in place of electric cables, they are to comply with the requirements of ~~11.17.2 to 11.17.6~~ 8.17.2 to 8.17.6, in addition to the applicable requirements in Section ~~7~~ 5.

Existing paragraphs Pt 10, Ch 1, 11.17.1 *and* 11.17.6 *have been renumbered* Pt 9, Ch 3, 8.17.1 *and* 8.17.6.

~~11.17.4~~ 8.17.4 Where the busbar trunking system is employed for circuits on and below the bulkhead deck, arrangements are to be made to ensure that circuits on other decks are not affected in the event of partial flooding under the normal angles of inclination given in ~~1.11~~ Pt 1, Ch 1, 4.4. and 4.5 for essential electrical equipment.

Existing paragraphs Pt 10, Ch 1, 11.17.5 *and* 11.17.6 *have been renumbered* Pt 9, Ch 3, 8.17.5 *and* 8.17.6.

~~11.18~~ 8.18 Cable segregation

Existing paragraph Pt 10, Ch 1, 11.18.1 *has been renumbered* Pt 9, Ch 3, 8.18.1.

~~11.18.1~~ 8.18.1 To reduce mutual interference, cables with different signal levels are to be grouped in accordance with Table ~~1.11.8~~ 3.8.8 and installed with the separation distances as shown in Table ~~1.11.9~~ 3.8.9.

Table ~~1.11.8~~ 3.8.8 Cable segregation groups

Table ~~1.11.9~~ 3.8.9 Separation distances, mm

Section ~~13~~ 9

Equipment – ~~Heating~~ heating, lighting and accessories

~~13.1~~ 9.1 Heating and cooking equipment

Existing paragraphs Pt 10, Ch 1, 13.1.1 *to* 13.1.3 *have been renumbered* Pt 9, Ch 3, 9.1.1 *to* 9.1.3.

~~13.6~~ 9.2 Socket outlets and plugs

Existing paragraphs Pt 10, Ch 1, 13.6.1 *to* 13.6.4 *have been renumbered* Pt 9, Ch 3, 9.2.1 *to* 9.2.4.

~~13.7~~ 9.3 Enclosures

Existing paragraph Pt 10, Ch 1, 13.7.1 *has been renumbered* Pt 9, Ch 3, 9.3.1.

Section ~~15~~ 10

Navigation and manoeuvring systems

Existing paragraphs Pt 10, Ch 1, 15.1.1 *to* 15.1.7 *have been renumbered* Pt 9, Ch 3, 10.1.1 *to* 10.1.7.

~~15.1~~ 10.1 Steering gear

~~15.1.1~~ 10.1.1 The requirements of ~~15.1.2 to 15.1.7~~ 10.1.2 to 10.1.7 are to be read in conjunction with those in Pt 6, Ch 1.7.

~~15.1.2~~ 10.1.2 Two exclusive circuits, fed from the main source of electrical power and each having adequate capacity to supply all the motors which may be connected to it simultaneously, are to be provided for each electric or electrohydraulic steering gear arrangement consisting of one or more electric motors. One of these circuits may pass through the emergency switchboard, if installed, *see also* Pt 6, Ch 1,7.

Existing paragraphs Volume 2, Part 10, Chapter 1, 15.1.3 *to* 15.1.5 *have been renumbered* Volume 2, Part 9, Chapter 3, 10.1.3 *to* 10.1.5.

~~15.1.6~~ 10.1.6 Where specified and agreed by the Naval Authority, in ships of category NS3, if an auxiliary steering gear is not electrically powered or is powered by an electric motor primarily intended for other services, the main steering gear may be fed by one circuit from the main switchboard. Consideration would be given to other protective arrangements other than described in ~~15.1.5~~ 10.1.5 for such a motor primarily intended for other services.

Existing paragraph Volume 2, Part 10, Chapter 1, 15.1.7 *has been renumbered* Volume 2, Part 9, Chapter 3, 10.1.7.

~~15.2~~ 10.2 Thruster systems for steering

Existing paragraph Volume 2, Part 10, Chapter 1, 15.2.1 *has been renumbered* Volume 2, Part 9, Chapter 3, 10.2.1.

~~15.4~~ 10.3 Thruster systems for manoeuvring

Existing paragraphs Volume 2, Part 10, Chapter 1, 15.4.1 *to* 15.4.3 *have been renumbered* Volume 2, Part 9, Chapter 3, 10.3.1 *to* 10.3.3.

~~15.6~~ 10.4 Navigational aids

Existing paragraphs Volume 2, Part 10, Chapter 1, 15.6.1 *and* 16.6.2 *have been renumbered* Volume 2, Part 9, Chapter 3, 10.4.1 *and* 10.4.2.

~~15.6.1~~ 10.4.1 Navigational aids ~~as required by the Naval Authority~~ are to be fed from the emergency source of electrical power. *See also* ~~3.2.7(d)(ii)~~ Ch 2, 5.2.7 (d) (ii).

~~15.6.2~~ 10.4.2 ~~Ships having a notation NAV 1~~ For ships with navigational arrangements of one watchkeeper, navigational aids are to have an alternative supply fed from the main source of electrical power, independent of the emergency switchboard, with automatic changeover facilities.

Volume 2, Part 9

Electrotechnical Systems

Chapter 4

Electrical Protection

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and co-ordination of the electrical protection philosophy of the electrical generation and distribution systems and connected auxiliary consumers.

This Chapter details the requirements for protection of the electrical generation and distribution systems and connected equipment to provide continuity of service and protection of equipment and personnel from fire and other hazards resulting from electrical failures.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77, NATO Naval Ship Code* Chapter IV Regulation 10.

■ *Section 1*
Functional requirements

1.1 Functional requirements

1.1.1 All electrical equipment shall be suitably protected against damage to itself under normal, reasonable foreseeable abnormal and fault conditions and to prevent injury to personnel or damage to other equipment.

■ *Section 2*
Performance requirements

2.1 Performance requirements

2.1.1 Efficient means, suitably located, shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger.

2.1.2 Suitable arrangements for the protection of mechanically connected equipment due to the effects of electrical overloads shall be provided.

2.1.3 Suitable arrangements for the protection of electrical equipment due to the effects of mechanical overloads shall be provided.

2.1.4 Suitable protection arrangements for lightning strikes shall be provided.

2.1.5 Personnel, equipment and platform are to be protected from the risk of static electricity.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 6 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section ~~6~~ 4*
System design – ~~Protection~~ protection

~~6.1~~ 4.1 General

Existing paragraphs Pt 10, Ch 1, 6.1.1 *to* 6.1.10 *have been renumbered* Pt 9, Ch 4, 4.1.1 *to* 4.1.10.

~~6.1.4~~ 4.1.4 Protection systems are to be developed using a systematic design procedure incorporating verification and validation methods to ensure successful implementation of the requirements above. Details of the procedures used are to be submitted when requested. An approved copy of the details required by ~~1.2.4 and 1.2.5~~ Ch 1, 1.4.6 and 1.4.7 is to be retained on board and made available to the LR Surveyor on request. Access to protection relays is to be restricted, such that they will generally only be adjusted by authorised personnel to avoid incorrect operation.

Existing paragraphs Pt 10, Ch 1, 6.1.5 *and* 6.1.6 *have been renumbered* Pt 9, Ch 4, 4.1.5 *and* 4.1.6.

~~6.1.7~~ 4.1.7 Protection for battery circuits is to be provided at a position external and adjacent to the battery compartments. Where arrangements comply with ~~12.3.5~~ Ch 2, 7.3.5, the protection may be installed at a suitable location in the battery compartment.

~~6.1.8~~ 4.1.8 Protection may be omitted from the following:

(a) Engine-starting battery circuits.
(b) Circuits for which it can be shown that the risk resulting from spurious operation of the protective device may be greater than that resulting from a fault.

Existing paragraphs Pt 10, Ch 1, 6.1.9 *and* 6.1.10 *have been renumbered* Pt 9, Ch 4, 4.1.9 *and* 4.1.10.

~~6.2~~ 4.2 Protection against short-circuit

Existing paragraph Pt 10, Ch 1, 6.2.1 *to* 6.2.4 *have been renumbered* Pt 9, Ch 4, 4.2.1 *to* 4.2.4.

~~6.2.2~~ 4.2.2 The rated short-circuit making and breaking capacity of every protective device is to be adequate for the prospective fault level at its point of installation; the requirements for circuit breakers and fuses are detailed in 4.5 and 4.6 respectively.

~~6.2.3~~ 4.2.3 The prospective fault current is to be calculated for the following set of conditions:

(a) all generators, motors and, where applicable, all transformers, connected as far as permitted by any interlocking arrangements~~;~~.

(b) a fault of negligible impedance close up to the load side of the protective device.

Existing paragraph Pt 10, Ch 1, 6.2.4 *has been renumbered* Pt 9, Ch 4, 4.2.4.

~~6.3~~ 4.3 Protection against overload

Existing paragraph Pt 10, Ch 1, 6.3.1 *and* 6.3.2 *have been renumbered* Pt 9, Ch 4, 4.3.1 *and* 4.3.2.

~~6.3.2~~ 4.3.2 Fuses of a type intended for short-circuit protection only (e.g., ~~fuse links~~ high-voltage fuses or fuses complying with IEC 60~~0~~269-1~~,~~: *Low-voltage fuses – Part 1: General requirements*, of type ‘a’) are not to be used for overload protection.

~~6.4~~ 4.4 Protection against earth faults

Existing paragraphs Pt 10, Ch 1, 6.4.1 *to* 6.4.4 *have been renumbered* Pt 9, Ch 4, 4.4.1 *to* 4.4.4.

~~6.4.4~~ 4.4.4 Insulated neutral systems with harmonic distortion of the voltage waveform, which may result in earth fault currents exceeding the level given in ~~6.4.2~~ 4.4.2 because of capacitive effects, are to be provided with arrangements to isolate the faulty circuit(s).

~~6.5~~ 4.5 Circuit-breakers

Existing paragraphs Pt 10, Ch 1, 6.5.1 *and* 6.5.4 *have been renumbered* Pt 9, Ch 4, 4.4.1 *and* 4.4.5.

~~6.5.3~~ 4.5.3 The fault ratings considered in ~~6.5.1~~ 4.5.1 and ~~6.5.2~~ 4.5.2, are to be assigned on the basis that the device is suitable for further use after fault clearance.

~~6.5.4~~ 4.5.4 Circuit-breakers selection is, and ratings are, to be in accordance with the relevant requirements of IEC 60092-202: *Electrical installations in ships – Part 202: System design – Protection*. Alternative methods acceptable to LR of selecting suitable circuit-breakers may be considered.

~~6.6~~ 4.6 Fuses

Existing paragraphs Pt 10, Ch 1, 6.6.1 *and* 6.6.2 *have been renumbered* Pt 9, Ch 4, 4.6.1 *and* 4.6.2.

~~6.7~~ 4.7 Circuit-breakers requiring back-up by fuse or other device

Existing paragraphs Pt 10, Ch 1, 6.7.1 *and* 6.7.4 *have been renumbered* Pt 9, Ch 4, 4.7.1 *and* 4.7.4.

~~6.7.3~~ 4.7.3 The combination of back-up device and circuit-breaker is to have a short-circuit performance at least equal to that of a single circuit-breaker satisfying the requirements of ~~6.5~~ 4.5.

Existing paragraph Pt 10, Ch 1, 6.7.4 *has been renumbered* Pt 9, Ch 4, 4.7.4.

~~6.8~~ 4.8 Protection of generators

Existing paragraphs Pt 10, Ch 1, 6.8.1 *to* 6.8.8 *have been renumbered* Pt 9, Ch 4, 4.8.1 *to* 4.8.8.

~~6.8.1~~ 4.8.1 The protective gear required by ~~6.8.2 and 6.8.3~~ 4.8.2 and 4.8.3 is to be provided as a minimum.

~~6.8.2~~ 4.8.2 Generators not arranged to run in parallel are to be provided with a circuit-breaker arranged to open simultaneously, in the event of a short-circuit, an overload or an under-voltage, all insulated poles. In the case of generators rated at less than 50 kW, a multipole linked switch with a fuse, complying with ~~5.3.2~~ 4.3.2, in each insulated pole will be acceptable.

~~6.8.3~~ 4.8.3 Generators arranged to operate in parallel are to be provided with a circuit-breaker arranged to open simultaneously, in the event of a short-circuit, an overload or an under-voltage, all insulated poles. This circuit-breaker is to be provided with reverse power protection with time delay, selected or set within the limits of 2 per cent to 15 per cent of full load to a value fixed in accordance with the characteristics of the prime mover~~;~~. ~~a~~ A fall of 50 per cent in the applied voltage is not to render the reverse power mechanism inoperative, although it may alter the amount of reverse power required to open the breakers.

Existing paragraph Pt 10, Ch 1, 6.8.4 *has been renumbered* Pt 9, Ch 4, 4.8.4.

~~6.8.5~~ 4.8.5 ~~Generators~~ All high-voltage generators and low-voltage generators having a capacity of 1500 kVA or above are to be equipped with a protective device which, in the event of a short-circuit in the generator or in the cables between the generator and its circuit-breaker, will instantaneously open the circuit-breaker and de-excite the generator.

~~6.8.6~~ 4.8.6 The voltage and time delay settings of the undervoltage release mechanism(s) required by ~~6.8.2 and 6.83~~ 4.8.2 and 4.8.3 are to be chosen to ensure that the discriminative action required by ~~6.1.1(a)~~ 4.1.1(a) is maintained.

~~6.8.7~~ 4.8.7 The protection of electrical power generation and distribution systems is to be so arranged that, in the event of failure of a protection device, including integrated multifunction relays, sufficient power can be supplied to all essential services, *see also* ~~5.2.4~~ Ch 3,4.2.4.

Existing paragraph Pt 10, Ch 1, 6.8.8 *has been renumbered* Pt 9, Ch 4, 4.8.8.

~~6.9~~ 4.9 Load management

Existing paragraphs Pt 10, Ch 1, 6.9.1 *to* 6.9.5 *have been renumbered* Pt 9, Ch 4, 4.9.1 *to* 4.9.5.

~~6.9.4~~ 4.9.4 The load management of power systems supplying electric propulsion motors is to satisfy the requirements of ~~16.3~~ Pt 4, Ch 5, 4.3.

Existing paragraph Pt 10, Ch 1, 6.9.5 *has been renumbered* Pt 9, Ch 4, 4.9.5.

~~6.10~~ 4.10 Feeder circuits

Existing paragraph Pt 10, Ch 1, 6.10.1 *has been renumbered* Pt 9, Ch 4, 4.10.1.

~~6.10.1~~ 4.10.1 Isolation and protection of each feeder circuit is to be ensured by a multipole circuit-breaker or linked switch with a fuse in each insulated conductor. Protection is to be in accordance with ~~6.2 and 6.3~~ 4.2 and 4.3. The protective devices are to allow excess current to pass during the normal accelerating period of motors.

~~6.11~~ 4.11 Motor circuits

Existing paragraphs Pt 10, Ch 1, 6.11.1 *to* 6.11.5 *have been renumbered* Pt 9, Ch 4, 4.11.1 *to* 4.11.5.

~~6.12~~ 4.12 Protection of transformers

Existing paragraphs Pt 10, Ch 1, 6.12.1 *and* 6.12.2 *have been renumbered* Pt 9, Ch 4, 4.12.1 *and* 4.12.2.

~~6.13~~ 4.13 Harmonic filters

Existing paragraphs Pt 10, Ch 1, 6.13.1 *to* 6.13.3 *have been renumbered* Pt 9, Ch 4, 4.13.1 *to* 4.13.3.

■ *Section ~~8~~ 5*

Protection from electric arc hazards within electrical equipment

Existing sub-Sections Pt 10, Ch 1, 8.1 *and* 8.2 *have been renumbered* Pt 9, Ch 4, 5.1 *and* 5.2.

~~8.1~~ 5.1 General

~~8.1.1~~ 5.1.1 An assessment is to be carried out in accordance with ~~8.2.1~~ 5.2.1 for all electrical equipment within which an arcing fault could occur, such as:

- harmonic filters;
- motor starter panels;
- semiconductor converters;
- switchboards, section boards and distribution boards;
- transformers.

~~8.2~~ 5.2 Hazard identification and assessment

~~8.2.1~~ 5.2.1 An assessment is to be carried out to identify the hazards and their consequences for personnel resulting from electric arcs within the electrical equipment identified in ~~8.1.1~~ 5.1.1. The purpose of the assessment is to demonstrate that the design incorporates adequate measures to reduce the risk of injury to personnel should an arcing fault occur within the electrical equipment, and that this will help to ensure both personnel and ship safety.
Details of the following are to be submitted:

(a) each task to be performed, e.g., switching, equipment maintenance, instrument observation or cleaning;
(b) the hazards to personnel that could result from an electric arc occurring during each task, and the hazards to personnel that could result from the electric arc;
(c) the methods to be used to help to prevent electric arcs;
(d) the methods to be used to protect personnel from hazards resulting from electric arcs within electrical equipment.

~~8.3~~ 5.3 Calculations to be submitted

Existing paragraph Pt 10, Ch 1, 8.3.1 *has been renumbered* Pt 9, Ch 4, 5.3.1.

~~8.4~~ 5.4 Testing and trials

Existing paragraph Pt 10, Ch 1, 8.4.1 *has been renumbered* Pt 9, Ch 4, 5.4.1.

■ ~~1.19~~ *Section 6*

Protection of electrical equipment against the effects of lightning strikes

Existing sub-Section Pt 10, Ch 1, 1.19 *has been renumbered* Pt 9, Ch 4, Section 6.

6.1 General

~~*1.19.1*~~ *6.1.1* Precautions are to be taken to protect essential electronic equipment that may be susceptible to damage from voltage pulses attributable to the secondary effects of lightning. This may be achieved by suitable design and/or the use of additional protective devices, such as surge arrestors. Resultant induced voltages may be further reduced by the use of earthed metallic screened cables. ~~*See also* Section 20.~~

Existing paragraph Pt 10, Ch 1, 20.1.1 *has been renumbered* Pt 9, Ch 4, 6.1.2.

Volume 2, Part 9

Electrotechnical Systems

Chapter 5

Hazardous Areas

Effective Date 1 January 2015

■ *Scope*

This Chapter details the requirements for installations and equipment selection to minimise the risk of ignition of explosive gas or dust atmospheres.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77 NATO Naval Ship Code*, Chapter IV, Regulation 18.

■ *Section 1*
Functional requirements

1.1 Functional requirements

1.1.1 The design, selection and installation of mechanical and electrical equipment for use in explosive gas or dust atmospheres are to be such as to minimise the sources of ignition.

■ *Section 2*
Performance requirements

2.1 Performance requirements

2.1.1 In order to facilitate the proper selection and installation of equipment to be used safely in areas where explosive gas or dust atmospheres may occur, such dangerous or hazardous areas are to be identified in accordance with an acceptable National or International Standard.

2.1.2 Hazardous areas shall be divided into zones in accordance with a National or International Standard agreed by the Naval Administration.

2.1.3 Electrical equipment or wiring shall not be installed in hazardous areas unless essential for operational purposes or safety enhancement.

2.1.4 Where electrical or mechanical equipment is installed in hazardous areas, it shall be of a type suitable for the environment in which it will be operated. Equipment shall be selected, installed and maintained in accordance with National or International Standards. Equipment for hazardous areas shall be evaluated and certified by an accredited testing authority or notified body recognised by the Naval Administration.

2.1.5 Where machinery is operated in a potentially flammable atmosphere, a means is to be provided to detect any abnormal parameters which may lead to ignition of the atmosphere.

2.1.6 Any failure that can change the categorisation of a hazardous area shall be indicated by an alert.

2.1.7 The integrity of the boundary of the hazardous area shall be such as not to compromise the safety of the adjacent space.

2.1.8 Suitable indication of the nature of the potential hazards shall be provided at the entrance(s) to the space, and on the equipment where applicable.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Section 4 is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section ~~14~~ 4*
Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts

Existing paragraphs Pt 10, Ch 1, 14.1.1 *to* 14.1.5 *have been renumbered* Pt 9, Ch 5, 4.1.1 *to* 4.1.5.

~~14.1~~ 4.1 General

~~14.1.4~~ 4.1.4 Equipment that is to be installed in an area where both explosive gases and combustible dusts can be present is to be selected in accordance with both ~~14.2 and 14.3~~ 4.2 and 4.3.

~~14.1.5~~ 4.1.5 For permanent secondary battery installations, *see* ~~Section 12~~ Ch 2, Section 7.

~~14.2~~ 4.2 Selection of equipment for use in explosive gas atmospheres

Existing paragraphs Pt 10, Ch 1, 14.2.1 *to* 14.2.8 *have been renumbered* Pt 9, Ch 5, 4.2.1 *to* 4.2.8.

~~14.2.1~~ 4.2.1 When equipment is to be installed in areas where an explosive gas atmosphere may be present, it is generally to be of a type providing protection against ignition of the gases encountered and compliant with the relevant Parts of IEC 60079~~,~~: ~~*(Electrical Apparatus for) Explosive Gas Atmospheres*~~ *Explosive atmospheres*, or ~~an acceptable and relevant Natioanl or Navy Standard, unless permitted otherwise by 14.2.4, 14.2.5 or 14.2.6~~, an agreed specified standard where applicable, *see* 4.2.4, 4.2.5 or 4.2.6.

~~14.2.2~~ 4.2.2 The equipment protection type permitted depends on the hazardous zone where the equipment is to be located, as defined in ~~14.5~~ 4.5. For certain locations on the ship other requirements may limit installations to specific equipment types and/or particular applications.

~~14.2.3~~ 4.2.3 Equipment for **zone 0** or **zone 1**, with the exception of simple apparatus as defined in ~~14.2.4~~ 4.2.4 or ~~14.2.5~~ 4.2.5, is to be certified or approved by a National or other appropriate Authority. Equipment without independent certification or approval may be considered for installation in **zone 2**.

Existing paragraphs Pt 10, Ch 1, 14.2.4 *and* 14.2.5 *have been renumbered* Pt 9, Ch 5, 4.2.4 *and* 4.2.5.

~~14.2.4~~ 4.2.4 In **zone 0**, the following may be considered:

(a) intrinsically safe, category ‘a’ (Ex ‘ia’); or

(b) simple electrical apparatus and components (for example, thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically safe circuits of category ‘ia’, not capable of storing or generating electrical power or energy in excess of the limits given in IEC 60079-14~~,~~: Explosive atmospheres – Part 14: *Electrical installations design, selection and erection*.

~~14.2.6~~ 4.2.6 In **zone 2**, the following may be considered:

(a) apparatus permitted within **zone 0** or **zone 1**;

(b) type of protection ‘n’ or ‘N’;

(c) equipment such as control panels, protected by purging and pressurisation and capable of being verified by inspection as meeting the requirements of IEC 60079-2: *Explosive atmospheres – Part 2: Equipment protection by pressurized enclosures "p"*; or

(d) radio aerials having robust construction, meeting the relevant requirements of IEC 60079-15: *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*. Additionally, in the case of transmitter aerials, it is to be shown, by detailed study or measurement, or by limiting the peak radiated power and field strength to 1 W and 30 V/m, respectively, that they present negligible risk of inducing incendive sparking in adjacent structures or equipment.

Existing paragraphs Pt 10, Ch 1, 14.2.7 *and* 14.2.8 *have been renumbered* Pt 9, Ch 5, 4.2.7 *and* 4.2.8.

~~14.3~~ 4.3 Selection of equipment for use in the presence of combustible dusts

Existing paragraphs Pt 10, Ch 1, 14.3.1 *to* 14.3.5 *have been renumbered* Pt 9, Ch 5, 4.3.1 *to* 4.3.5.

~~14.3.1~~ 4.3.1 Where apparatus is to be installed in **hazardous areas**, as defined by 1~~4.5.3~~ 4.5.3, associated with the presence of combustible dusts, it is, when practicable, to be of a type certified or approved by a National or other appropriate Authority for the dusts and, additionally, any explosive gases encountered.

Existing paragraph Pt 10, Ch 1, 14.3.2 *has been renumbered* Pt 9, Ch 5, 4.3.2.

~~14.3.3~~ 4.3.3 Where apparatus is to be installed in **extended hazardous areas**, as defined by ~~14.5.3~~ 4.5.3, associated with the presence of combustible dust, the following may be considered:

(a) apparatus permitted within a hazardous area associated with the combustible dust(s) that can be present;

(b) apparatus having degree of protection IP5X, or better, and having a surface temperature under normal operating conditions not exceeding the auto-ignition temperature of the dust(s) that can be present; and

(c) apparatus of a type which ensures absence of sparks or arcs and hot spots during normal operation.

~~14.3.4~~ 4.3.4 Where equipment certified for combustible dusts is not available, consideration will be given to the use of apparatus complying, as a minimum, with the following requirements provided no explosive gases will be present:

(a) the enclosure is to be at least dust protected (IP5X) having, when type tested, an ingress of fine dust within the enclosure not exceeding 10 g per m^3 of free air space; and

(b) the surface temperature of the apparatus, under the most onerous combination of normal operating conditions, but in the absence of a dust layer, is not to exceed two-thirds of the minimum ignition temperature in degrees Celsius of the dust/air mixture(s) that can be present; or

(c) the equipment is to be certified intrinsically safe having a temperature classification ensuring compliance with (b); or

(d) pressurised and operated in accordance with procedures ensuring, prior to its re-energisation, the absence of dust within the enclosure following loss of pressurisation and consequent ~~shut-down~~ shutdown, and having surface temperature complying with (b); or

(e) simple apparatus included in intrinsically safe circuits or radio aerials, complying with ~~14.2.4, 14.2.5 or 14.2.6~~ 4.2.4, 4.2.5 or 4.2.6 respectively.

~~14.3.5~~ 4.3.5 Consideration may also be given to arrangements complying with IEC 60092-506~~,~~: *Electrical installation in ~~Ships~~ ships – Part 506: ~~/~~ Special ~~Features~~ features: Ships carrying specific dangerous goods and materials hazardous only in bulk*.

~~14.4~~ 4.4 Installation of electrical equipment

Existing paragraphs Pt 10, Ch 1, 14.4.1 *and* 14.4.2 *have been renumbered* Pt 9, Ch 5, 4.4.1 *and* 4.4.2.

~~14.4.1~~ 4.4.1 The method of installation and application of electrical equipment suitable for use in explosive gas atmospheres or in the presence of combustible dusts is to be in accordance with IEC 60079-14: *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*, or the National Code of Practice relevant to the Standard with which the equipment complies. ~~Any special requirements laid down by the equipment certification documentation are also to be observed.~~ The ambient temperature range for which the apparatus is certified is to be taken to be –20°C to 40°C, unless otherwise stated, and account is to be taken of this when assessing the suitability of the equipment for the auto-ignition temperature of the gases and dusts encountered. Any special requirements laid down by the equipment certification documentation are also to be observed.

Existing paragraph Pt 10, Ch 1, 14.4.2 *has been renumbered* Pt 9, Ch 5, 4.4.2.

~~14.5~~ 4.5 Hazardous zones and spaces

Existing paragraphs Pt 10, Ch 1, 14.5.1 *to* 14.5.7 *has been renumbered* Pt 9, Ch 5, 4.5.1 *to* 4.5.7.

~~14.5.2~~ 4.5.2 Hazardous areas associated with flammable liquids or gases are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

- **zone 0**: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently;
- **zone 1**: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally;
- **zone 2**: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

See IEC 60079-10~~, *Electrical apparatus for explosive gas atmospheres: Classification of hazardous areas*~~-1: *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*.

~~14.5.3~~ 4.5.3 Hazardous areas associated with solid substances or packaged liquids are classified into zones based upon the frequency of the occurrence and duration of an explosive atmosphere due to the presence of gas and/or dust, as follows:

- **hazardous area**: area in which an explosive atmosphere is likely to occur in normal operation (comparable with **zone 1**)
- **extended hazardous area**: area in which an explosive atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only (comparable with **zone 2**).

See IEC 60079-10-2~~,~~: *Explosive atmospheres-Part 10-2: Classification of areas – Combustible dust atmospheres*, or IEC 60092-506~~,~~: *Electrical Installation in ~~Ships~~ ships-Part 506 – Special ~~Features~~ features – Ships carrying specific dangerous goods and materials hazardous only in bulk*. An explosive atmosphere may exist due to gas and/or dust.

Existing paragraph Pt 10, Ch 1, 14.5.4 *has been renumbered* Pt 9, Ch 5, 4.5.4.

~~14.5.5~~ 4.5.5 The following zones or spaces are regarded as hazardous, **zone 0**:

(a) the interiors of those spaces, tanks, piping systems and equipment defined by ~~14.5.4~~ 4.5.4(a) and (b); and
(b) enclosed, unventilated spaces containing pipework or equipment defined by ~~14.5.4~~ 4.5.4(b) and (e).

~~14.5.6~~ 4.5.6 The following zones or spaces are regarded as hazardous, **zone 1**:

(a) the interiors of spaces containing dangerous goods as defined by ~~14.5.4~~ 4.5.4(d);
(b) unventilated spaces separated by a single bulkhead or deck from a cargo defined by ~~14.5.4~~ 4.5.4(a);
(c) ventilated spaces containing pipework or equipment defined by ~~14.5.4~~ 4.5.4(b) and (e);
(d) zones within a 1,5 m radius of ventilation outlets, hatches or doorways or other openings into spaces defined by (a), (b) or (c), or within 1,5 m of the ventilation outlets of spaces regarded by ~~14.7~~ 4.7 as open areas and which contain the pipework or equipment defined by ~~14.5.4~~ 4.5.4(b) or (e). Where the hazard results from flammable gas or vapour having a density relative to that of air of more than 0,75 m, the hazardous zone is considered to extend vertically downward to solid deck, or for a distance of 9 m, whichever is the lesser;
(e) zones within a 1,5 m radius of flanged joints, or glands or other openings defined by ~~14.5.4~~ 4.5.4(b); in the case of gas or vapour having a relative density of more than 0,75 m, the hazardous zone is considered to extend vertically downwards as described under (d);
(f) zones within a 1,5 m radius of flanged joints, or glands or other openings defined by ~~14.5.4~~ 4.5.4(e) and (f);
(g) zones within a 1,5 m radius of bunds or barriers intended to contain spillage of liquids defined by ~~14.5.4~~ 4.5.4(a);
(h) zones on open deck within a 1,5 m radius of any opening into a space defined by (a) or (b); and
(j) enclosed or semi-enclosed spaces with direct opening into a **zone 1** hazardous location.

~~14.5.7~~ 4.5.7 The following zones or spaces are regarded as hazardous, **zone 2**:

(a) ventilated spaces separated by a single bulkhead or deck from a **zone 0** space;
(b) zones on open deck extending 1,5 m beyond those defined by ~~14.5.6~~ 4.5.6(d), (e), (f), (g) or (h);
(c) zones within a 1,5 m radius of ventilation inlets serving spaces defined by ~~14.5.6~~ 4.5.6(a) or (c); and
(d) enclosed or semi-enclosed spaces with direct opening into a **zone 2** hazardous location.

~~14.6~~ 4.6 Semi-enclosed spaces

Existing paragraph Pt 10, Ch 1, 14.6.1 *has been renumbered* Pt 9, Ch 5, 4.6.1.

~~14.7~~ 4.7 Ventilation

Existing paragraphs Pt 10, Ch 1, 14.7.1 *to* 14.7.3 *have been renumbered* Pt 9, Ch 5, 4.7.1 *to* 4.7.3.

~~14.7.1~~ 4.7.1 Where an enclosed or semi-enclosed space is provided with mechanical ventilation ensuring at least 12 air changes/hour, and leaving no areas of stagnant air, it may be regarded in consideration of hazardous zones as would otherwise be defined by ~~14.5.5~~ 4.5.5(b), ~~14.5.6~~ 4.5.6(e) or (j) and ~~14.5.7~~ 4.5.7(d), as an open area.

~~14.8~~ 4.8 Pressurisation

Existing paragraphs Pt 10, Ch 1, 14.8.1 *and* 14.8.2 *have been renumbered* Pt 9, Ch 5, 4.8.1 *and* 4.8.2.

~~14.8.1~~ 4.8.1 A space having access to a hazardous space or zone defined as zone 1 or zone 2 may be regarded as non-hazardous if fulfilling all the following conditions:

(a) access is by means of an air-lock, having gastight steel doors, the inner of which, as a minimum, is self-closing without any hold-back arrangement;
(b) it is maintained at an ~~over pressure~~ overpressure relative to the external hazardous area by ventilation from a non-hazardous area;
(c) the relative air pressure within the space is continuously monitored and so arranged that, in the event of loss of ~~over pressure~~ overpressure, an alarm is given and the electrical supply to all equipment not of a type suitable for zone 1 is automatically disconnected. Where the shutdown of equipment could introduce a hazard, an alarm may be given, in lieu of shutdown, upon loss of ~~over pressure~~ overpressure, and a means of disconnection of electrical equipment not of a type suitable for zone 1, capable of being controlled from an attended station, provided in conjunction with an agreed operational procedure; where the means of disconnection is located within the space then it is to be effected by equipment of a type suitable for zone 1;
(d) any electrical equipment required to operate upon loss of ~~over pressure~~ overpressure, lighting fittings (*see* ~~5.7.3~~ Ch 6, 4.5.3) and equipment within the air-lock, is to be of a type suitable for zone 1; and
(e) means are to be provided to prevent electrical equipment, other than of a type suitable for zone 1, being energised until the atmosphere within the space is made safe, by air renewal of at least 10 times the capacity of the space.

~~14.8.2~~ 4.8.2 A space having access to a hazardous space or zone defined as zone 2 may be regarded as non-hazardous if fulfilling all the following conditions:

(a) access is by means of a self-closing gastight steel door without any hold-back arrangement;
(b) it is maintained at an ~~over pressure~~ overpressure relative to the external hazardous area by ventilation from a non-hazardous area;
(c) the relative air pressure within the space is continuously monitored and so arranged that, in the event of loss of ~~over pressure~~ overpressure, an alarm is given. A means of disconnection of electrical equipment not of a type suitable for zone 2 is to be provided; where the means of disconnection is located within the space then it is to be effected by equipment of a type suitable for zone 2;
(d) any electrical equipment required to operate upon loss of ~~over pressure~~ overpressure (e.g., lighting fittings, *see* ~~5.7.3~~ Ch 6, 4.5.3), is to be of a type suitable for zone 2.

~~14.9~~ 4.9 Cable and cable installation

Existing paragraph Pt 10, Ch 1, 14.9.1 *has been renumbered* Pt 9, Ch 5, 4.9.1.

~~14.9.2~~ 4.9.2 In addition to the requirements of ~~Section 11~~ Ch 3, Section 8, cables for circuits that are not intrinsically safe, which are located in hazardous zones or spaces, or which may be exposed to cargo oil, oil vapour or gas, are to be either:

(a) mineral insulated with copper sheath; or
(b) armoured or braided for earth detection; or
(c) otherwise adequately protected against mechanical or chemical damage, within zone 2 or non-hazardous locations only; or
(d) as otherwise specifically permitted elsewhere within this Section.

~~14.9.3~~ 4.9.3 Armouring, braiding and other metal coverings of cables installed in dangerous zones or spaces are to be effectively earthed at least at both ends, *see* ~~1.13.4~~ Ch 1,2.4.4.

Existing paragraphs Pt 10, Ch 1, 14.9.1 *to* 14.9.7 *have been renumbered* Pt 9, Ch 5, 4.9.1 *to* 4.9.7.

~~14.9.5~~ 4.9.5 Cables associated with intrinsically safe circuits are to be used only for such circuits. They are to be physically separated from cables associated with non-intrinsically safe circuits, e.g., neither installed in the same protective casing nor secured by the same fixing clip. Consideration may be given to other arrangements complying with IEC 60079-14~~,~~: *Explosive atmospheres – Part 14 : Electrical installations design, selection and erection*.

~~14.10~~ 4.10 Requirements for oil supply ships intended for the carriage in bulk of oil cargoes having a flash point not exceeding 60°C (closed-cup test)

Existing paragraphs Pt 10, Ch 1, 14.10.1 *to* 14.10.4 *have been renumbered* Pt 9, Ch 5, 4.10.1 *to* 4.10.4.

~~14.10.1~~ 4.10.1 In order to eliminate potential sources of ignition from hazardous areas on board Oil Supply Ships electrical equipment is to be selected and installed in accordance with IEC 60092: *Electrical installations in ships – Part 502: Tankers – Special features*.

~~14.10.3~~ 4.10.3 Further to the requirements of paragraph ~~14.5.6~~ 4.5.6, open deck, or semi-enclosed spaces on open deck, within 3 m of the ventilation outlets of tanks defined in ~~14.5.4~~ 4.5.4 (a), which permit the flow of small volumes of vapour or gas mixtures caused by thermal variation are to be regarded as hazardous zone 1.

~~14.10.4~~ 4.10.4 Further to the requirements of paragraph ~~14.5.7~~ 4.5.7, open deck extending 2 m beyond those defined by ~~14.5.6~~ 4.5.6(e) are to be regarded as hazardous zone 2.

~~14.11~~ 4.11 Special requirements for ships with spaces for carrying vehicles, helicopters and aircraft, with fuel in their tanks

Existing paragraph Pt 10, Ch 1, 14.11.1 *has been renumbered* Pt 9, Ch 5, 4.11.1.

(*Part only shown*)
~~14.11.1~~ 4.11.1 Ships with closed spaces carrying vehicles, helicopter and aircraft with fuel having a flashpoint not exceeding 60ºC:

(b) where the ventilation system ~~required by the Naval Authority~~ is arranged to operate continuously and is sufficient to provide at least ten air changes per hour, whenever vehicles are on board, above a height of 45 cm from the vehicle deck, or any platform on which vehicles are carried, electrical equipment having an enclosure of ingress protection rating of at least IP 55 may be accepted as an alternative to that of a safe type;

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Chapter 6

Lighting

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy for the lighting system.

This Chapter details the requirements for sub-systems and equipment within the boundary of the lighting system. Approval will be in respect of the integrity of the lighting system (including emergency and navigation lighting), configuration, EMC enclosure configuration (where appropriate), control, monitoring, alert and safety systems, and other critical support systems.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77 NATO Naval Ship Code*, Chapter IV, Regulations 11 and Chapter VII, Regulation 15.

■ *Section 1*

Functional requirements

1.1 Functional requirements

1.1.1 Illumination shall be provided appropriate for location and operational requirements in both normal and emergency conditions.

1.1.2 Lighting systems shall provide sufficient illumination to conduct any escape, evacuation and rescue activity during an emergency following loss of either main or emergency lighting.

1.1.3 A Low Location Lighting system shall allow embarked persons to safely and effectively locate muster and evacuation stations.

■ *Section 2*

Performance requirements

2.1 Performance requirements

2.1.1 The siting of light fittings is to consider the transfer of heat to adjacent surfaces.

2.1.2 Illumination levels are to meet operational requirements.

2.1.3 System design intent of the lighting system is to permit the vessel to be operated in accordance with the CONOPS.

2.1.4 Main lighting systems are to provide a suitable level of illumination to allow:

(a) safe access to areas of the vessel that require it for normal operations;
(b) operation and control of the vessel.

2.1.5 The lighting systems are to be arranged such that a single failure will not cause total loss of illumination in any attended compartment.

2.1.6 In the event of loss of main lighting, at locations where illumination must be maintained for operational purposes, transitional lighting shall be provided. The transitional lighting is to be available for a period acceptable to the Naval Administration.

2.1.7 To meet operational requirements, lighting levels are to be controllable locally.

2.1.8 Operational lighting shall be provided in areas where there is an operational requirement for different levels of illumination from that provided by the main lighting system.

2.1.9 Emergency lighting shall provide sufficient illumination to locations essential for any Escape, Evacuation and Rescue.

2.1.10 The lighting system design intent shall:

(a) provide arrangements such that sufficient illumination is provided under foreseeable abnormal conditions to enable embarked persons to locate escape routes, escape exits, muster stations (if provided) and evacuation stations.
(b) enable emergency lighting to operate for a period as necessary to complete all Escape, Evacuation and Rescue activities.
(c) ensure that the emergency lighting has minimised susceptibility to damage.

2.1.11 System design intent of the navigational lights shall provide arrangements such that sufficient illumination is provided under normal and foreseeable abnormal conditions to enable the vessel to display the proper light configuration in compliance with the *International Regulations for Preventing Collisions at Sea* (COLREGS) in force.

■ *Section 3*

Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Section 4 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

Section 4 Lighting systems

~~13.2~~ 4.1 Lighting - General

4.1.1 The lighting systems are to be arranged such that a single failure will not cause total loss of illumination in any attended compartment.

4.1.2 In the event of loss of main lighting, at locations where illumination must be maintained for operational purposes, transitional lighting shall be provided until the main lighting is restored or emergency lighting is operational. The transitional lighting is to be available for a period acceptable to the Naval Administration.

4.1.3 To meet operational requirements, lighting levels are to be controllable locally.

4.1.4 Lamp holders, lamps and light fittings are to be in accordance with IEC 60092-306, *Electrical installations in ships – Part 306: Equipment – Luminaires and lighting accessories*.

Existing paragraphs Pt 10, Ch1,13.4.2 *and* 13.4.3 *have been renumbered* Pt 9, Ch 6, 4.1.5 *and* 4.1.6.

~~13.5~~ 4.2 Discharge lighting

Existing paragraph Pt 10, 13.5.1 *has been renumbered* Pt 9, Ch 6, 4.2.1.

~~5.7~~ 4.3 Lighting circuits

Existing paragraphs Pt 10, Ch 1, 5.7.1 *and* 5.7.2 *have been renumbered* Pt 9, Ch 6, 4.3.1 *and* 4.3.2.

~~5.7.3~~ 4.3.3 Lighting for enclosed hazardous spaces is to be supplied from at least two final sub-circuits to permit light from one circuit to be retained while maintenance is carried out on the other. One of these circuits may be an emergency circuit, provided it is normally energised in which case the arrangements are to comply with ~~Section 3~~ Ch 2, Section 5.

Existing paragraphs Pt 10, Ch 1, 5.7.5 *and* 5.7.6 *have been renumbered* 4.3.4 *and* 4.3.5

~~18.1~~ 4.4 Emergency lighting

Existing paragraphs Pt 10, Ch 1, 18.1.1 *and* 18.1.8 *have been renumbered* Pt 9, Ch 6, 4.4.1 *and* 4.4.8.

~~18.1.3~~ 4.4.3 The illuminance provided by any one lighting circuit is to be adequate to permit safe evacuation in an emergency, having regard to the possible presence of smoke, *see* ~~18.4~~ 4.8.

Existing paragraphs Pt 10, Ch 1, 18.1.4 *to* 18.1.8 *have been renumbered* Pt 9, Ch 6, 4.4.4 *to* 4.4.8.

~~15.5~~ 4.5 Navigation lights

Existing paragraphs Pt 10, Ch 1, 15.5.1 *to* 15.5.10 *have been renumbered* Pt 9, Ch 6, 4.5.1 *to* 4.5.10.

~~15.5.1~~ 4.5.1 Navigation lights are to be connected separately to a distribution board reserved for this purpose only and accessible to the officer of the watch. This distribution board is to be connected to the emergency source of electrical power in compliance with, ~~3.2.7(c) and 3.2.9(a)~~ Ch 2, 5.2.7 (c) and 5.2.9 (a). An alarm is to be activated in the event of failure of a power supply from the distribution board.

Existing paragraph Pt 10, Ch 1, 15.5.2 *has been renumbered* Pt 9, Ch 6, 4.5.2.

~~15.5.3~~ 4.5.3 Provision is to be made on the navigating bridge for the navigation lights to be transferred to an alternative circuit fed from the main source of electrical power. ~~Where there is no dedicated emergency source of electrical power because there are multiple main electrical power sources as permitted by 3.1.3, the navigation light panel is to be connected to at least two independent sources of power with arrangements to transfer between the two sources.~~ *See also* Ch 2, 5.1.3.

Existing paragraph Pt 10, Ch 1, 15.5.4 *has been renumbered* Pt 9, Ch 6, 4.5.4.

~~15.5.5~~ 4.5.5 For navigation lights using light emitting diodes (consisting of multiple light sources) means to ensure that the overall luminous intensity of the navigation light is sufficient are to be provided in addition to the alarm to indicate the complete loss of the navigation light illumination required by ~~15.5.3~~ 4.7.4. For replacement navigation lights, *see* ~~1.5.6~~ Ch 1, 1.7.7.

~~15.5.6~~ 4.5.6 To satisfy ~~15.5.5~~ 4.7.5, an audible and visual alarm is to be activated to notify the bridge Officer of the Watch when the luminous intensity of the light reduces below the level required by the IMO *Convention on the International Regulations for Preventing Collisions at Sea*. Alternative measures to ensure continuing acceptable performance of navigation lights using light emitting diodes may be considered that are in accordance with:

- IMO Res. MSC.253(83), *Performance Standards for Navigation Lights, Navigation Light Controllers and associated Equipment*, and
- EN 14744, *Inland navigation vessels and sea-going vessels – Navigation light*, or a relevant National, International or Naval Standard.

Where alternative measures are proposed that require verification by personnel of the luminous intensity of navigation lights using light emitting diodes, detials of the periodic inspection implementation and acceptance by the ~~Naval Authority~~ Naval Administration are to be submitted for consideration.

~~15.5.7~~ 4.5.7 Navigation light power supply units installed to convert, control and/or monitor the distribution board power supply required by ~~15.5.1~~ 4.7.1 above for connection to the light source(s) (e.g., for LED type navigation lights) are, in the event of a short-circuit on the unit output, to disconnect or limit the supply to prevent further damage and activate an alarm.

~~15.5.8~~ 4.5.8 Navigation light power supply units are to be self-monitoring, detecting failures of the unit itself and activating an alarm. These are to include:

- detection of system lock-ups (program hangs);
- means to detect failure of navigation light switching command input circuits or links; and
- means to detect failure of the navigation light monitoring arrangements required to provide the alarms required by ~~15.5.4~~ 4.7.4 and 1~~5.5.5~~ 4.7.5, as applicable.

~~15.5.9~~ 4.5.9 The navigation light power supply failure alarms required by ~~15.5.1~~ 4.7.1 are not to be displayed as a group alarm. Other navigation light alarms may be grouped for each navigation light where means are provided for personnel to determine the cause of the alarm. Activation of more than one of the navigation light alarms as a result of a single failure is to be prevented.

~~15.5.10~~ 4.5.10 ~~Naval Authority~~ Specified requirements including the use of battery power navigation lights are to be complied with and may be accepted as an alternative to the above.

~~18.4~~ 4.6 Escape route or low location lighting (LLL)

Existing paragraphs Pt 10, Ch 1, 18.4.1 *to* 18.4.4 *have been renumbered* Pt 9, Ch 6, 4.6.1 *to* 4.6.4.

~~18.4.1~~ 4.6.1 The escape route or low location lighting (LLL) required by the ~~Naval Authority~~ Naval Administration specified standard, where satisfied by electric illumination, is to comply with the requirements of this sub-Section.

~~18.4.2~~ 4.6.2 The LLL system is to be provided with an emergency source of electrical power as required by ~~3.2~~ Ch 2, 5.2 and also be connected to the main source of electrical power, with automatic changeover facilities located adjacent to the control panel, *see also* ~~1.18~~ Ch 1, 2.5.

~~18.4.3~~ 4.6.3 The power supply arrangements to the LLL are to be arranged so that a single fault or a fire in any one fire zone or deck does not result in loss of the lighting in any other zone or deck. This requirement may be satisfied by the power supply circuit configuration, use of fire-resistant cables complying with ~~11.5.3~~ Ch 3, 8.5.3, and/or the provision of suitably located power supply units having integral batteries adequately rated to supply the connected LLL for a minimum period of 60 minutes.

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Chapter 7

Control, Alerts and Safety Systems

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy of machinery control, alert and safety systems as well as ship safety systems that are essential to the safety of a naval vessel.

This Chapter details the requirements for hard wired, solid state and programmable electronic systems within the boundary for provision of essential services.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77 NATO Naval Ship Code*, Chapter IV, Regulations 13, 14 and 15.

■ *Section 1*
Functional requirements

1.1 Functional requirements

1.1.1 Systems essential for propulsion, manoeuvring, electrical power generation and safety of the ship shall be provided with effective means of control and alert to ensure fault identification and safe operation under all ship operational conditions.

1.1.2 Alert systems shall inform Operators as soon as reasonably practicable of deviations from normal operation of essential machinery and systems during all ship operations.

1.1.3 Safety systems shall ensure that any serious faults of machinery or system which present an immediate danger shall initiate corrective action, where appropriate, to remove the risk of danger.

■ *Section 2*
Performance requirements

2.1 Performance requirements

2.1.1 The design, construction and operation of control, alert and safety systems shall employ human-centred activities.

2.1.2 Systems essential for propulsion, manoeuvring, electrical power generation and safety of the ship shall be provided with a continuous electrical supply. An audible and visual alert shall be initiated in the event of the failure of any of the power supplies.

2.1.3 The control system must operate essential machinery and systems in a safe, controlled and stable manner throughout the machinery's/systems' defined operational limits and shall recover automatically in a safe manner after a loss of power supply.

2.1.4 It shall be possible to control machinery/systems from only one location at a time, with clear indication showing the location of the control. Transfer between control stations without altering the control set points shall be provided. Transfer of control location will be indicated with visual and audible indication.

2.1.5 Appropriate indication and feedback shall be provided at each control station to confirm that the system has responded to the Operator's demands. The status of automatic control systems shall be indicated.

2.1.6 Means are to be available to disable the automatic or remote control operation of essential machinery and systems to allow inspection and maintenance tasks to be performed safely on the machinery and systems.

2.1.7 Indications of impending slowdown/shutdown of essential machinery and systems shall be provided at applicable locations with provision to take alternative actions if approved.

2.1.8 Automated control systems which utilise stored energy to start essential machinery shall be configured not to exhaust the stored energy completely and to provide an alert when the stored energy is below a critical limit.

2.1.9 The monitoring system for system parameters is to have integrity appropriate for its intended purpose.

2.1.10 Where it is proposed to operate the essential machinery in an unattended space, no matter what period, sufficient controls, alarms and safeguards are to be provided to enable safe and effective operation of the equipment. A dedicated control position shall be provided.

2.1.11 Failure of a control system is not to result in the loss of ability to provide essential services by alternative means.

2.1.12 Control, Alert and Safety systems shall be designed to fail to the least hazardous condition. This condition shall be determined for the complete installation.

2.1.13 Operators shall have an independent, high integrity method to disconnect all energy sources that shall put machinery for essential safety functions into a known safe state.

2.1.14 An alert system with appropriate controls and displays shall be located at key locations.

2.1.15 Where parameters of the alert system can be adjusted, the integrity of the system shall be maintained.

2.1.16 The status of an alert shall be clearly visible and a means to accept it from all appropriate locations. Visual indication of the alarm shall remain until the fault is cleared.

2.1.17 Design of machinery safety systems shall be such that equipment must be reset manually before being restarted.

2.1.18 Where the function of a safety system might lead to a greater hazard than the loss of the equipment, an override should be provided.

2.1.19 The status of standby machinery and systems shall be indicated at appropriate control stations as agreed with the Naval Administration.

2.1.20 Systems shall be readily usable under all intended operating conditions and shall support effective and efficient operation. Adequate safeguards against incorrect operation shall be provided.

2.1.21 The systems' repeatability and accuracy shall be adequate for the proposed use and shall be maintained at their specified value during their expected lifetime and normal use.

2.1.22 System design shall take account of any constraints or limitations imposed due to equipment or machinery.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 5 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section ~~2~~ 4*
Essential features for control, alarm and safety systems

Existing Section title Pt 9, Ch 1, 2 *and existing sub-Section title* 2.1 *have been renumbered* Pt 9, Ch 7, 4.1 *and* 4.2.

~~2.1~~ 4.1 General

Existing paragraph Pt 9, Ch 1, 1.1.1 *has been renumbered* Pt 9, Ch 7, 4.1.1.

4.1.2 The design, construction and installation of control alarm and safety systems and control stations shall incorporate the ergonomics requirements of Pt 10, Ch 1.

Existing paragraph Pt 9, Ch 1, 2.1.1 *has been deleted*.

~~2.2~~ 4.2 Control stations for machinery

Existing paragraphs Pt 9, Ch 1, 2.2.1 *to* 2.2.6 *have been renumbered* Pt 9, Ch 7, 4.2.1 *to* 4.2.6.

~~*2.2.7* For additional requirements where control stations incorporate visual display units and keyboard facilities, *see* 2.10.~~

~~2.3~~ 4.3 Alarm systems, general requirements

Existing paragraphs Pt 9, Ch 1, 2.3.1 *to* 2.3.22 *have been renumbered* Pt 9, Ch 7, 4.3.1 *to* 4.3.22.

~~*2.3.3*~~ *4.3.3* Alerts associated with machinery and equipment required to satisfy this sub-Section are to be categorised according to the urgency and type of response required by the crew, as described in the IMO *Code on Alerts and Indicators, 2009*. The assignment of category to each alert is to be evaluated on the basis not only of the machinery or equipment being monitored, but also the complete installation. Categories not included in an alarm system may be omitted from the system design. Details of alternative alert management proposals supported with evidence of service experience may be submitted for consideration by LR ~~provided they are acceptable to the Naval Authority~~. The alternative alert management is to be clearly specified.

Existing paragraphs Pt 9, Ch 1, 2.3.4 *to* 2.3.15 *have been renumbered* Pt 9, Ch 7, 4.3.4 *to* 4.3.15.

~~*2.3.16*~~ *4.3.16* The alarm system is to be capable of being tested during normal machinery operation, *see* ~~6.1.2~~ Ch 11, 1.2.2.

Existing paragraphs Pt 9, Ch 1, 2.3.17 *to* 2.3.20 *have been renumbered* Pt 9, Ch 7, 4.3.17 *to* 4.3.20.

~~*2.3.21*~~ *4.3.21* Where practicable, alarms displayed on monitors are to be displayed in the order in which they occur. Alarms requiring manual ~~shut-down~~ shutdown or ~~slow-down~~ slowdown action are to be given visual prominence.

Existing paragraph Pt 9, Ch 1, 2.3.22 *has been renumbered* Pt 9, Ch 7, 4.3.22.

Existing paragraph Pt 9, Ch 1, 4.1.2 *has been renumbered* Pt 9, Ch 7, 4.3.23.

~~4.1.2~~ 4.3.23 Where a first stage alarm together with a second stage alarm and automatic ~~shut-down~~ shutdown of machinery are required in the relevant Table of this Section, the sensors and circuits utilised for the second stage alarm and automatic ~~shut-down~~ shutdown are to be independent of those required by the first stage alarm.

~~2.4~~ 4.4 Safety systems, general requirements

Existing paragraphs Pt 9, Ch 1, 2.4.2 *to* 2.4.12 *have been renumbered* Pt 9, Ch 7, 4.4.1 *to* 4.4.11.

~~*2.4.1* Where safety systems are provided, the requirements of 2.4.2 to 2.4.12 are to be satisfied. The requirements of this sub-Section apply, where relevant, to the safety systems installed on the equipment defined in 1.2.3 including those provided in addition to those safeguards required by Section 3 or other Sections of the Rules.~~

~~2.4.12~~ 4.4.11 As far as practicable, the safety system required by ~~2.4.2(b)~~ 4.4.1 (b) is to be arranged to effect a rapid reduction in speed or power.

~~2.5~~ 4.5 Control systems, general requirements

Existing paragraphs Pt 9, Ch 1, 2.5.1 *to* 2.5.7 *have been renumbered* Pt 9, Ch 7, 4.5.1 *to* 4.5.7.

~~2.5.1~~ 4.5.1 ~~Where control systems are provided, the requirements of 2.5.2 to 2.5.7 are to be satisfied.~~ The control system is to be designed such that normal operation of the controls cannot induce detrimental mechanical or thermal overloads in the machinery.

Existing paragraphs Pt 9, Ch 1, 2.5.2 *to* 2.5.4 *have been renumbered* Pt 9, Ch 7, 4.5.2 *to* 4.5.4.

~~2.5.5~~ 4.5.5 Remote or automatic controls are to be provided with ~~sufficient~~ suitable instrumentation (e.g., alarms and indications) at the relevant control stations to ensure effective control by duty personnel and to indicate that the system is functioning correctly.

Existing paragraph Pt 9, Ch 1, 2.5.6 *has been renumbered* Pt 9, Ch 7, 4.5.6.

~~2.5.7~~ 4.5.7 Failure of a control system is not to result in the loss of ability to provide essential services by alternative means. This may be achieved by manual control or redundancy within the control system or redundancy in machinery and equipment, *see also* ~~2.14.2~~ Ch 8, 5.5.2. Instrumentation is to be provided at local manual control stations to ensure effective operation of the machinery by duty personnel.

~~2.6~~ 4.6 Bridge control for main propulsion machinery

Existing paragraphs Pt 9, Ch 1, 2.6.2 *to* 2.6.9 *have been renumbered* Pt 9, Ch 7, 4.6.1 *to* 4.6.8.

~~*2.6.1* Where a bridge control system for main propulsion machinery is to be fitted, the requirements of 2.6.2 to 2.6.8 are to be satisfied.~~

Existing paragraph Pt 9, Ch 1, 2.3.22 *has been renumbered* Pt 9, Ch 7, 4.3.22.

~~2.6.5~~ 4.6.4 Remote control of the propulsion machinery is to be from only one control station at any one time, *see also* ~~2.2.5~~ 4.2.5. Main propulsion control units on the navigating bridge may be interconnected. Means are to be provided at the ~~main machinery~~ control station to ensure smooth transfer of control between the bridge and ~~machinery~~ other control stations.

Existing paragraph Pt 9, Ch 1, 2.6.6 *has been renumbered* Pt 9, Ch 7, 4.6.5.

~~2.6.7~~ 4.6.6 Audible and visual alarms are to operate on the bridge and in the alarm system required by ~~3.2~~ Ch 1, 4.2 if any power supply to the bridge control system fails. Where practicable, the preset speed and direction of thrust are to be maintained until corrective action is taken.

~~2.6.8~~ 4.6.7 At least two means of communication are to be provided between the bridge and the main control station in the machinery space. One of these means may be the bridge control system; the other is to be independent of the main electrical power supply. *See also* ~~2.2.2~~ 4.2.2 and Pt 1, Ch 2,5.10.

~~2.6.9~~ 4.6.8 Automation systems are to be designed in a manner such that a threshold warning of impending or imminent ~~slow-down~~ slowdown or ~~shut-down~~ shutdown of the propulsion system is given to the officer in charge of the navigational watch in time to assess navigational circumstances in an emergency. In particular, the systems are to control, monitor, report, alert and take safety action to slow down or stop propulsion while providing the officer in charge of the navigational watch an opportunity to manually intervene, except for those cases where manual intervention will result in total failure of the engine and/or propulsion equipment within a short time, for example in the case of overspeed.

~~2.7~~ 4.7 Valve control and indication systems

~~2.7.1~~ 4.7.1 Systems providing remote control and indication functions for valves in Mobility and Ship Type category systems are to ensure effective operation, with due regard to any ~~Naval Authority~~ specified requirements for operation under damage conditions. The requirements of ~~2.7.2 to 2.7.5~~ 4.7.2 to 4.7.5 are to be satisfied.

Existing paragraphs Pt 9, Ch 1, 2.7.1 *to* 2.7.6 *have been renumbered* Pt 9, Ch 7, 4.7.1 *to* 4.7.6.

Volume 2, Part 9

Electrotechnical Systems

Chapter 8

Programmable Electronic Systems

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy of Programmable Electronic Systems used for machinery control, alert and safety systems as well as ship safety systems that are essential to the safety of a naval vessel.

This Chapter details the requirements for programmable electronic systems within the boundary for provision of essential services.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77 NATO Naval Ship Code*, Chapter IV, Regulation 15.

■ *Section 1*

Functional requirements

1.1 Functional requirements

1.1.1 Additional hazards shall not be introduced by the application of programmable electronic systems.

1.1.2 The integration of systems or sub-systems shall ensure the required functionality of the platform under normal and foreseeable abnormal conditions and shall not introduce additional hazards.

■ *Section 2*

Performance requirements

2.1 Performance requirements

2.1.1 The design, construction and operation of programmable systems shall employ human-centred activities.

2.1.2 The required level of safety shall be realised by appropriate activities throughout the equipment lifecycle.

2.1.3 The Programmable Electronic Systems shall be arranged such that the configuration is protected against unauthorised or unintended change.

2.1.4 Where applicable, the synchronisation of date and time stamping between separate equipment should be considered.

2.1.5 There shall be no degradation of the sub-system functionality when integrated into a larger system.

2.1.6 Programmable electronic systems shall maintain specified levels of performance in operation, and where necessary, under fault conditions.

2.1.7 Systems shall be readily usable under all intended operating conditions and shall support effective and efficient operation. Adequate safeguards against incorrect operation shall be provided.

2.1.8 The systems' repeatability and accuracy shall be adequate for the proposed use and shall be maintained at their specified value during their expected lifetime and normal use.

2.1.9 Program and data held in the system shall be protected from corruption by loss of power.

2.1.10 The Programmable Electronic Systems configuration shall be identified and controlled throughout the lifecycle.

2.1.11 System design shall take account of any constraints or limitations imposed due to equipment or machinery.

2.1.12 Failure of one part of the integrated system shall not affect the functionality of other parts except for those functions directly dependent on the defective part.

■ *Section 3*

Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 5 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section 4*
General requirements

4.1 General

4.1.1 The design, construction and installation of programmable electronic systems shall incorporate the ergonomics requirements of Pt 10, Ch 1.

■ ~~2.10~~ *Section 5*
~~Programmable electronic systems – General requirements~~ Programmable electronic systems (PES)

5.1 General requirements

Existing paragraphs Pt 9, Ch 1, 2.10.1 *and* 2.10.2 *to* 2.10.20 *have been renumbered* Pt 9, Ch 8, 5.1.1 *and* 5.1.3 *to* 5.1.21.

~~*2.10.1*~~ *5.1.1* The requirements of this ~~sub-~~Section are to be complied with where control, alarm or safety systems incorporate programmable electronic equipment. Systems for essential services and safety critical applications, systems incorporating shared data communication links and systems which are integrated are to comply with the additional requirements of ~~2.12, 2.13 and 2.14~~ 5.2, 5.3 and 5.4 as applicable. ~~For systems complying with ISO 17894, *Ships and marine technology – Computer applications – General principles for the development and use of programmable electronic systems in marine applications*, see 2.1.2.~~

Existing paragraph Pt 9, Ch 1, 2.1.2 *has been renumbered* Pt 9, Ch 8, 5.1.2.

~~*2.10.2*~~ *5.1.3* Where programmable electronic systems share resources, any components that can affect the ability to effectively provide required control, alarm or safety functions are to fulfil the requirements of ~~2.10 to 2.14~~ 5.1 to 5.5 related to providing those required functions.

Existing paragraphs Pt 9, Ch 1, 2.10.3 *and* 2.10.4 *have been renumbered* Pt 9, Ch 8, 5.1.4 *and* 5.1.5.

~~*2.10.5*~~ *5.1.6* Programmable electronic equipment is to be certified by a recognised authority as suitable for the environmental conditions in which it is intended to operate, *see also* ~~2.13.3~~ 5.4.3.

~~*2.10.6*~~ *5.1.7* Emergency stop functions are to be hardwired and independent of any programmable electronic equipment. Alternatively, the system providing emergency stop functions is to comply with the requirements of ~~2.13.2~~ 5.4.2 and/or ~~2.13.8~~ 5.4.8.

~~*2.10.7*~~ *5.1.8* Programmable electronic equipment is to be provided with self-monitoring capabilities such that hardware and functional failures will initiate an audible and visual alarm in accordance with the requirements of ~~2.3~~ 4.3 and, where applicable, ~~4.2~~ Ch 1, 4.2. Hardware failure indications are to enable faults to be identifiable at least down to the level of the lowest replaceable unit and the self-monitoring capabilities are to ensure that diagnostic information is readily available.

~~*2.10.8*~~ *5.1.9* Means are to be provided to recover or replace data required for safe and effective system operation lost as a result of component failure. The submission required by ~~1.2.6~~ Ch 1, 1.4.21 is to address reinstatement of system operation following data loss.

~~*2.10.9*~~ *5.1.10* System configuration, programs and data are to be protected against loss or corruption in the event of failure of any power supply. For Mobility category and safety critical systems, *see* ~~2.13.6~~ 5.4.6.

~~*2.10.10*~~ *5.1.11* Where it is necessary to store data required for system operation in volatile memory, a back-up power supply is to be provided that prevents data loss in the event of loss of the normal power supply. The submission required by ~~1.2.6~~ Ch 1, 1.4.21 is to include details of any routine maintenance necessary and the measures necessary to restore system operation in the event of data loss as a result of power supply failure.

~~*2.10.11*~~ *5.1.12* Back-up power supplies required by ~~2.10.10~~ 5.1.11 are to be rated to supply the connected load for a defined period of time that allows sufficient time for the re-instatement of supply in the event of loss of the normal power supply as a result of failure of a main source of electrical power. This period is in any case to be not less than 30 minutes.

~~*2.10.12*~~ *5.1.13* Where regular battery replacement is required to maintain the availability of volatile memory back-up power supply required by ~~2.10.10~~ 5.1.11, these are to be included in the schedule of batteries required by ~~Pt 10, Ch 1,1.13.2 and Ch 1,12.7~~ Ch 1, 1.4.17 and Ch 2, 7.7, irrespective of battery type and size. Applicable entries in this schedule are to note that these batteries are not for safety critical systems or essential or emergency services.

Existing paragraphs Pt 9, Ch 1, 2.10.13 *to* 2.10.15 *have been renumbered* Pt 9, Ch 8, 5.1.14 *to* 5.1.16.

~~*2.10.16*~~ *5.1.17* Display units are to comply with the requirements of an acceptable National or International Standard, e.g., IEC 60950~~:2005, *Information technology equipment – Safety, including electrical business equipment 1: Information technology equipment – Safety – Part 1: General requirements*,~~ in respect of emission of ionising radiation.

Existing paragraphs Pt 9, Ch 1, 2.10.17 *to* 2.10.19 *have been renumbered* Pt 9, Ch 8, 5.1.18 *to* 5.1.20.

~~*2.10.20*~~ *5.1.21* Software lifecycle activities, e.g., design, development, supply and maintenance, are to be carried out in accordance with an acceptable quality management system. Software quality plans are to be submitted. These are to demonstrate that the provisions of ISO/IEC 90003: *Software engineering – Guidelines for the application of ISO 9001:2000 to computer software* or an acceptable International, National or naval standard, are incorporated. The plans are to define responsibilities for the lifecycle activities, including verification, validation, module testing and integration with other components or systems.

~~2.11~~ 5.2 Data communication links

~~2.11.1~~ 5.2.1 Where control, alarm or safety systems use shared data communication links to transfer data, the requirements of ~~2.11.2 to 2.11.10~~ 5.2.2 to 5.2.10 are to be complied with. The requirements apply to local area networks, fieldbuses and other types of data communication link which make use of a shared medium to transfer control, alarm or safety related data between distributed programmable electronic equipment or systems.

Existing paragraph Pt 9, Ch 1, 2.11.1 *to* 2.11.11 *have been renumbered* Pt 9, Ch 8, 5.2.1 *to* 5.2.11.

~~2.11.3~~ 5.2.3 Loss of a data communication link is not to result in the loss of ability to operate any essential service by alternative means, *see also* ~~2.13.2~~ 5.4.2.

Existing paragraphs Pt 9, Ch 1, 2.11.4 *and* 2.11.5 *have been renumbered* Pt 9, Ch 8, 5.2.4 *and* 5.2.5.

~~2.11.6~~ 5.2.6 Means are to be provided to monitor performance and identify hardware and functional failures. An audible and visual alarm is to operate in accordance with the requirements of ~~2.3~~ 4.3 and, where applicable, ~~3.2~~ Ch 1, 4.2 in the event of a failure of an active or standby component.

~~2.11.7~~ 5.2.7 System self-monitoring capabilities are to be arranged to initiate transition to a defined safe state for the complete installation in the event of data communication failure, *see also* ~~2.5.4~~ 4.5.4.

Existing paragraph Pt 9, Ch 1, 2.11.8 *has been renumbered* Pt 9, Ch 8, 5.2.8.

~~2.11.9~~ 5.2.9 Data cables are to comply with the applicable requirements of ~~Pt 10, Ch 1,11~~ Ch 3, Section 8. Other media will be subject to special consideration.

Existing paragraphs Pt 9, Ch 1, 2.11.10 *and* 2.11.1 *have been renumbered* Pt 9, Ch 8, 5.2.10 *and* 5.2.11.

~~2.12~~ 5.3 Additional requirements for wireless data communication links

Existing paragraphs Pt 9, Ch 1, 2.12.1 *to* 2.12.6 *have been renumbered* Pt 9, Ch 8, 5.3.1 *to* 5.3.6.

~~2.12.1~~ 5.3.1 The requirements of this sub-Section are in addition to ~~2.11~~ 5.2 and apply to systems incorporating wireless data communication links.

~~2.12.2~~ 5.3.2 Wireless data communication links are not to be used for safety critical systems or essential services that are required for the propulsion or safety of the ship, except as permitted by ~~2.12.3~~ 5.3.3.

Existing paragraphs Pt 9, Ch 1, 2.12.3 *to* 2.12.5 *have been renumbered* Pt 9, Ch 8, 5.3.3 *to* 5.3.5.

~~2.12.6~~ 5.3.6 Compliance with different port state and local regulations pertaining to the use of radio-frequency transmission that would prohibit the operation of a wireless data communication link, due to frequency and power level restrictions, is not addressed by these requirements and is the responsibility of the Owner~~/Naval Authority and Operator~~.

~~2.13~~ 5.4 ~~Programmable electronic systems –~~ Additional requirements for Mobility category and safety critical systems

Existing paragraphs Pt 9, Ch 1, 2.13.1 *to* 2.13.10 *have been renumbered* Pt 9, Ch 8, 5.4.1 *to* 5.4.10.

~~2.13.1~~ 5.4.1 The requirements of ~~2.13.2 to 2.13.10~~ 5.4.2 to 5.4.10 are to be complied with where control, alarm or safety functions for Mobility category, or safety critical systems, incorporate programmable electronic equipment.

(a) Safety critical systems are those which provide functions intended to protect persons from physical hazards caused by engineering system failures, e.g., fire, explosion, etc., or to prevent mechanical damage which may result in the loss of a Mobility category system, e.g., main engine low lubricating oil pressure ~~shut-down~~ shutdown.

(b) Functions provided by Ship Type or Ancillary category systems may also be considered to be safety critical, e.g., domestic boiler low water level ~~shut-down~~ shutdown.

Existing paragraphs Pt 9, Ch 1, 2.13.2 *to* 2.13.6 *have been renumbered* Pt 9, Ch 8, 5.4.2 *to* 5.4.6.

~~2.13.7~~ 5.4.7 Failure of any power supply is to initiate an audible and visual alarm in accordance with the requirements of ~~2.3~~ 4.3 and, where applicable, ~~3.2~~ Ch 1, 4.2.

Existing paragraphs Pt 9, Ch 1, 2.13.8 *to* 2.13.10 *have been renumbered* Pt 9, Ch 8, 5.4.8 *to* 5.4.10.

~~2.14~~ 5.5 ~~Programmable electronic systems –~~ Additional requirements for integrated systems

Existing paragraphs Pt 9, Ch 1, 2.14.1 *to* 2.14.7 *have been renumbered* Pt 9, Ch 8, 5.5.1 *to* 5.5.7.

~~2.14.1~~ 5.5.1 The requirements of ~~2.14.2 to 2.14.7~~ 5.5.2 to 5.5.8 apply to integrated systems such as those providing a grouping of fire safety or crew and embarked personnel emergency safety functions (*see* Pt 10, Ch 1), power management systems and integrated control, alarm and monitoring systems for machinery, and include the interconnection of systems capable of independent operation to provide co-ordinated functions or common user interfaces.

Existing paragraph Pt 9, Ch 1, 2.14.2 *has been renumbered* Pt 9, Ch 8, 5.5.2.

~~2.14.3~~ 5.5.3 The system requirements specification, *see* ~~1.2.6~~ Ch 1, 14.21, is to identify the allocation of functions between modules of the integrated system, and any common data communication protocols or interface standards required to support these functions.

Existing paragraph Pt 9, Ch 1, 2.14.4 *has been renumbered* Pt 9, Ch 8, 5.5.4.

~~2.14.5~~ 5.5.5 Where the integration involves control functions for essential services or safety functions, including fire safety or crew and embarked personnel or emergency safety functions, the Risk Assessment (RA) required by Pt 1, Ch 2,3.3.8 is additionally to demonstrate that the integrated system will 'fail-safe', *see* ~~2.4.5 and 2.5.4~~ 4.4.5 and 4.5.4, and that essential services in operation will not be lost or degraded beyond acceptable performance criteria where specified by these Rules.

Existing paragraph Pt 9, Ch 1, 2.14.6 *has been renumbered* Pt 9, Ch 8, 5.5.6.

~~2.14.7~~ 5.5.7 Where information is required by the Rules or by ~~Naval Authority requirements~~ the System Design Description to be continuously displayed, the system configuration is to be such that the information may be viewed without manual intervention, e.g., the selection of a particular screen page or mode of operation. *See also* ~~2.10.20~~ 5.1.21.

5.5.8 Where applicable, date and time stamping between separate equipment shall be synchronised.

Volume 2, Part 9

Electrotechnical Systems

Chapter 9

Fire Safety and Ship Safety Systems

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy of the electrotechnical Classification aspects of Fire Safety and Ship Safety ships including Fire detection and alarms system, local application fire-fighting systems, watertight doors and power supply arrangements to other essential fire safety systems.

This Chapter details the requirements for sub-systems and equipment within the boundary of Fire Safety and Ship Safety ships in machinery and accommodation spaces.

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77, NATO Naval Ship Code*, Chapter VI, Regulation 7.

■ *Section 1*
Functional requirements

1.1 Functional requirements

1.1.1 A fire in the space of origin shall be detected and an alarm shall be provided for safe escape and fire-fighting activity.

1.1.2 Power to fire safety and ship safety systems shall be maintained in all reasonably foreseeable abnormal conditions.

1.1.3 A means of isolating ventilation and oil or fuel supplies to a space containing a fire shall be provided.

■ *Section 2*
Performance requirements

2.1 Performance requirements

2.1.1 An effective means of detecting and locating fires and alerting the navigation bridge, continuously manned control station and fire teams is to be provided in accordance with the IMO FSS Code.

2.1.2 Fixed fire detection and fire alarm system installations shall be suitable for the nature of the space, fire growth potential and potential generation of smoke and gases.

2.1.3 Manually operated call points shall be placed effectively to ensure a readily accessible means of notification.

2.1.4 The fire alarm is to sound the ship's general alarm if not responded to within a defined timescale.

2.1.5 Fixed fire detection and fire alarm system installations are to be demonstrated in accordance with a recognised Standard and shall be tested periodically in accordance with a recognised procedure.

2.1.6 Automatic activation of fire-fighting systems should have due regard for the function of the space and equipment protected.

2.1.7 Cable routes which supply power to fire safety and ship safety systems are to avoid high risk areas.

2.1.8 The activation of detection or extinction systems shall not result in the loss of essential services.

2.1.9 In the event of a fire, all equipment which could continue to provide a source of fuel or oxygen shall have the ability to be stopped remotely from outside the space.

2.1.10 Controls to fire safety systems shall be located outside of the space in which they serve.

2.1.11 All fire safety and ship safety systems shall be designed on the fail-safe principle.

2.1.12 The enclosures of electrical and control components necessarily situated below the bulkhead deck are to provide suitable protection against the ingress of water.

2.1.13 System design of all watertight and semi-watertight door systems is to ensure that a failure will not result in incorrect operation that will present a danger to the ship or personnel.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 5 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ ~~17.1~~ *Section 4*
~~Fire detection and alarm systems~~ Fire detection and fire alarm systems

Existing paragraph Pt 10, Ch 1, 17.1.1 *has been renumbered* Pt 9, Ch 9, 4.1.1.

4.1 General

~~17.1.1~~ 4.1.1 Fire detection and fire alarm systems are to comply with Chapter 9 of the *Fire Safety Systems Code (FSS Code)* and ~~17.1.2~~ 4.1.3 to ~~17.1.10~~ 4.1.13.

Existing paragraph Pt 9, Ch 1, 2.8.3 *has been renumbered* Pt 9, Ch 9, 4.1.2

~~2.8.3~~ 4.1.2 Fire detection control units, indicating panels, detector heads, manual call points and short-circuit isolation units are to be Type Approved in accordance with Test Specification Number 1 given in LR's Type Approval System for an environmental category appropriate for the locations in which they are intended to operate. For addressable systems, *see also* ~~2.10~~ Ch 8, Section 5.

~~2.8.4~~ 4.1.3 An audible fire-alarm is to be provided having a characteristic tone distinguishing it from the alarm system required by 2.3 or any other alarm system. The audible fire-alarm is to be immediately audible throughout the machinery spaces, the navigating bridge and at manned watch positions as designated by the ~~Naval Authority~~ specified fire safety standard. Facilities are to be provided in the fire detection system to initiate manually the fire-alarm from positions adjacent to all exits from machinery spaces, the navigating bridge and manned watch positions as designated by the ~~Naval Authority~~ specified fire safety standard.

Existing paragraphs Pt 10, Ch 1, 17.1.2 *to* 17.1.5 *and* 7.1.16 *to* 17.1.7 *have been renumbered* Pt 9, Ch 9, 4.1.4 *to* 4.1.7 *and* 4.1.10.

~~17.1.2~~ 4.1.4 Fire detection and fire alarm systems are to be provided with at least two power supplies. One supply is to be connected to the main source of electrical power and another supply is to be connected to the emergency source of electrical power required by ~~3.2~~ Ch 2, 5.2, or an accumulator battery capable of supplying power for the same period of time as the emergency source of electrical power. All power supply feeders for fire detection and alarm systems are to be in accordance with ~~11.6.4~~ Ch 3, 8.6.4.

~~17.1.3~~ 4.1.5 Automatic changeover facilities in accordance with ~~5.3.4~~ Ch 3, 4.3.4 are to be located in, or adjacent to, the main fire-control panel. Power supply changeover is to be achieved without adverse effect. Failure of any power supply is to operate an audible and visual alarm. *See also* ~~1.15~~ Ch 3, 8.10.6, 8.10.7 and ~~1.17~~ Ch 1, 2.5.

Existing paragraphs Pt 10, Ch 1, 17.1.4 *and* 17.1.5 *have been renumbered* Pt 9, Ch 9, 4.1.6 *and* 4.1.7.

Existing paragraph Pt 9, Ch 1, 2.8.17 *has been renumbered* Pt 9, Ch 9, 4.1.8.

Existing paragraphs Pt 10, Ch 1, 17.1.6 *and* 17.1.7 *have been renumbered* Pt 9, Ch 9, 4.1.9 *and* 4.1.10.

Existing paragraph Pt 9, Ch 1, 2.8.21 *has been renumbered* Pt 9, Ch 9, 4.1.11.

~~2.8.21~~ 4.1.11 Detectors and manually operated call points are to be grouped into sections. The activation of any detector or manually operated call point is to initiate a visual and audible fire-alarm signal at the control panel and indicating units. ~~If the signals have not received within two minutes an audible alarm is to be automatically sounded throughout the crew accommodation and service spaces, control stations and machinery spaces of category A. This alarm sounder system need not be an integral part of the detection system.~~

Existing paragraphs Pt 10, Ch 1, 17.1.8 *and* 17.1.9 *have been renumbered* Pt 9, Ch 9, 4.1.12 *and* 4.1.13.

Existing paragraph Pt 9, Ch 1, 2.8.22 *has been renumbered* Pt 9, Ch 9, 4.1.14.

Existing paragraph Pt 10, Ch 1, 17.1.10 *has been renumbered* Pt 9, Ch 9, 4.1.15.

Existing paragraphs Pt 9, Ch 1, 2.8.9, 2.8.4, 2.8.21, 2.8.6, 2.8.5, 2.8.7, 2.8.8, 2.8.10, 2.8.11, 2.8.13, 2.8.14, 2.8.15, 2.8.18, 2.8.19 *have been renumbered* Pt 9, Ch 9, 4.1.16, 4.1.17, 4.1.18 *to* 4.1.31.

~~2.8.4~~ 4.1.17 An audible fire-alarm is to be provided having a characteristic tone distinguishing it from ~~the~~ any other alarm system ~~required by 2.3 or any other alarm system~~. ~~The audible fire-alarm is to be immediately audible throughout the machinery spaces, the navigational bridge and at manned watch positions as designated by the Naval Authority.~~ Facilities are to be provided in the fire detection system to initiate manually the fire-alarm from positions adjacent to all exits from machinery spaces, the navigating bridge and manned watch positions as designated by the ~~Naval Authority~~ Naval Administration.

4.1.18 Activation of any detector or manually operated call point in a machinery space is to result in immediate activation of the audible fire alarm throughout that machinery space, the navigating bridge and at manned watch positions as designated by the Naval Administration.

~~2.8.21~~ 4.1.19 ~~Detectors and manually operated call points are to be grouped into sections.~~ The activation of any detector or manually operated call point in an accommodation area is to initiate a visual and audible fire-alarm signal at the control panel and indicating units. If the signals have not received attention within two minutes an audible alarm is to be automatically sounded throughout the crew accommodation and service spaces, control stations and machinery spaces of Category A. This alarm sounder system need not be an integral part of the detection system.

~~*2.8.17*~~ *4.1.20* The fixed fire detection ~~and fire alarm systems are~~ system is to be capable of remotely and individually identifying each detector and manually operated call point. At least one indicating unit is to be so located that it is easily accessible to responsible members of the crew. One indicating unit is to be located on the navigating bridge if the control panel is located in the central control station.

~~*2.8.6*~~ *4.1.21* The fire alarm system is to be designed with self-monitoring properties. Power or system failures are to initiate an audible alarm distinguishable from the fire-alarm. This alarm may be incorporated in the machinery alarm system as required by ~~2.3~~ Ch 7, 4.3.

~~*2.8.5*~~ *4.1.22* Where it is intended that detectors be installed in external locations, in addition to meeting the requirements for an environmental category suitable for open decks, *see* ~~2.8.8~~ 4.1.24, they are also to be tested for sun irradiation and ultraviolet exposure with satisfactory results.

Existing paragraphs Pt 9, Ch 1, 2.8.7 to 2.8.13 *have been renumbered* Pt 9, Ch 9, 4.1.23 *to* 4.1.27.

~~*2.8.14*~~ *4.1.28* Fire detection indicating panels are to denote the section in which a detector or manually operated call point has operated. At least one indicating panel is to be located on the navigating bridge unless specified otherwise by the ~~Naval Authority~~ Naval Administration.

Existing paragraphs Pt 9, Ch 1, 2.8.15 to 2.8.19 *have been renumbered* Pt 9, Ch 9, 4.1.29 *to* 4.1.31.

Existing paragraph Pt 10, Ch 1, 1.15.1 *has been renumbered* Pt 9, Ch 9, 4.1.32.

~~*1.15.1*~~ *4.1.32* ~~Where alarms are required by this Chapter they are to be arranged in accordance with Pt 9, Ch 1, 2.3.~~ Sound signal equipment, fire and general alarm bells are ~~not required~~ to be supplemented by visual indication~~, except in~~ areas having high levels of background noise, such as machinery spaces.

■ *Section ~~17~~ 5*
Fire safety systems

~~17.2~~ 5.1 Automatic sprinkler system

Existing paragraphs Pt 10, Ch 1, 17.2.1 *to* 17.2.5 *have been renumbered* Pt 9, Ch 9, 5.1.1 *to* 5.1.5.

~~2.9~~ 5.2 Fixed water-based local application fire-fighting systems

Existing paragraph Pt 9, Ch 1, 2.9.1 *has been renumbered* Pt 9, Ch 9, 5.2.1.

Existing paragraphs Pt 10, Ch 1, 17.3.1 *to* 17.3.4 *have been renumbered* Pt 9, Ch 9, 5.2.2 *to* 5.2.5.

~~*17.3.2*~~ *5.2.3* The fire detection, control and alarm systems are to be provided with an emergency source of electrical power required by ~~3.2~~ Ch 2, 5.2 or ~~3.3~~ 5.3 and are also to be connected to the main source of electrical power. Separate feeders, reserved solely for this purpose, with automatic changeover facilities located in, or adjacent to, the main control panel are to be provided.

~~*17.3.3*~~ *5.2.4* Failure of any power supply is to operate an audible and visual alarm. *See also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7 and ~~1.18~~ Ch 1, 2.5.

Existing paragraph Pt 10, Ch 1, 17.3.4 *has been renumbered* Pt 9, Ch 9, 5.2.5.

Existing paragraphs Pt 9, Ch 1, 2.9.4 *to* 2.9.8 *have been renumbered* Pt 9, Ch 9, 5.2.6 *to* 5.2.10.

~~*2.9.4*~~ *5.2.6* Where the ~~Navy or Naval Authority~~ System Design Description requires automatic ~~shut-down~~ shutdown and/or isolation of protected machinery and equipment in adjacent areas in the event of system activation, evidence is to be submitted to demonstrate compliance with 2.9.3. This submission is to address:

- ~~the applicable Navy or Naval Authority requirements;~~
- the failure effects of automatic ~~shut-down~~ shutdown and/or isolation measures on the machinery, equipment and the complete installation;
- the measures provided to prevent the loss of electrical power;
- the measures provided to prevent a reduction of the manoeuvrability of the ship; and
- the measures provided to ensure continued operation of the activated system.

The submission is to detail:

- permitted operating configurations while propulsion and steering machinery is operating;
- temporary interruptions in power supply while in port ~~allowed by the Navy or Naval Authority;~~ and
- power restoration measures following automatic ~~shut-down~~ shutdown and/or isolation of machinery or equipment. *See also* Pt 10, Ch 1,17.3.5.

Existing paragraph Pt 9, Ch 1, 2.9.5 *has been renumbered* Pt 9, Ch 9, 5.2.7.

~~*2.9.6*~~ *5.2.8* A control panel is to be provided for managing actions such as opening of valves, starting of pumps and initiation of alerts, and processing information from detectors. This panel is to be independent of the fire detection control unit required by ~~2.8~~ 4.1.

Existing paragraphs Pt 9, Ch 1, 2.9.7 *and* 2.9.8 *have been renumbered* Pt 9, Ch 9, 5.2.9 *and* 5.2.10.

Existing paragraph Pt 10, Ch 1, 17.3.5 *has been renumbered* Pt 9, Ch 9, 5.2.11.

~~*17.3.5*~~ *5.2.11* For the electrical safety of electrical and electronic equipment in areas protected by fixed water-based local application fire-fighting systems and adjacent areas where water may extend, the requirements of ~~17.3.6~~ 5.2.12 to ~~17.3.10~~ 5.2.16 apply. *See also* Pt 1, Ch 2,3.3.15.

Existing paragraphs Pt 10, Ch 1, 17.3.6 *and* 17.3.7 *have been renumbered* Pt 9, Ch 9, 5.2.12 *and* 5.2.13.

~~*17.3.8*~~ *5.2.14* In addition to the degree of protection requirements of ~~1.12.1~~ Ch 1, 2.2.6, electrical and electronic equipment enclosures located within protected areas and within adjacent areas are to provide adequate protection in the event of system operation.

~~*17.3.9*~~ *5.2.15* To demonstrate compliance with ~~17.3.8~~ 5.2.14, evidence of the suitability of electrical and electronic equipment for use in protected areas and adjacent areas is to be submitted in accordance with Pt 1, Ch 2,3.3.15 and 5.12.2. The evidence is to demonstrate that additional precautions have been taken, where necessary, in respect of:

(a) satisfying ~~17.3.6~~ 5.2.12 and ~~17.3.7~~ 5.2.13;

(b) the damage control and fire-fighting policy of the Navy or ~~Naval Authority~~ Naval Administration, *see* Pt 1, Ch 2,4.1.6;

(c) personnel protection against electric shock; and

(d) cooling airflow, where necessary, for equipment required to operate during system operation~~.~~;

(e) maintenance requirements for equipment before return to operation following system activation.

Any test evidence submitted is to consider the overall installation, including equipment types, system configuration and nozzles and the potential effects of airflows in the protected space.

~~*17.3.10*~~ *5.2.16* The evidence required by ~~17.3.9~~ 5.2.15 is to demonstrate the safe and effective operation of the overall arrangements in the event of system operation. This evidence is to demonstrate that exposure to system spray and/or water:

- cannot result in loss of essential services (e.g., unintended activation of automatic machinery ~~shut-down~~ shutdown);
- cannot result in loss of availability of emergency services;
- will not affect the continued safe and effective operation of electrical and electronic equipment required to operate during the required period of system operation;
- does not present additional electrical or fire hazards; and
- would require only identified readily replaceable components to be repaired or replaced.

The installation of electrical and electronic equipment required to provide essential or emergency services in enclosures with a degree of protection less than IP44 within areas exposed to direct spray is to be acceptable to LR, and evidence of suitability is to be submitted accordingly.

~~*17.3.11*~~ *5.2.17* Fixed water-based local application fire-fighting system electrically-driven pumps may be shared with:

- equivalent automatic sprinkler systems;
- equivalent main machinery space fire-fighting systems; or
- local fire-fighting systems for deep-fat cooking equipment;

provided that the shared use is accepted by the Navy or ~~Naval Authority~~ Naval Administration as complying with their applicable regulations within the specified fire safety standard and the arrangements comply with the requirements of ~~17.3.12~~ 5.2.18 to ~~17.3.14~~ 5.2.20.

Existing paragraphs Pt 10, Ch 1, 17.3.12 *to* 17.3.14 *have been renumbered* Pt 9, Ch 9, 5.2.18 *to* 5.2.20.

Existing paragraphs Pt 9, Ch 1, 2.9.3, 2.9.9 *to* 2.9.13 *have been renumbered* Pt 9, Ch 9, 5.2.21 *to* 5.2.26.

~~*2.9.9*~~ *5.2.22* Systems installed in periodically unattended machinery spaces are to, additionally, be capable of automatic release and the arrangements are to be in accordance with ~~2.9.10~~ 5.2.23 to ~~2.9.13~~ 5.2.25.

~~*2.9.10*~~ *5.2.23* A minimum of two fire detectors ~~are~~ is to be provided for each protected area. One is to be a flame detector and the other is to be a smoke or heat detector, as considered appropriate to the nature of the risk and ambient conditions. The system is to be activated upon detection by two of the detectors. A fault in one detector is to initiate an alarm at an attended control station and is not to inhibit activation of the system under the control of the other detector or manually. Detector faults are not to cause activation of the system.

Existing paragraph Pt 9, Ch 1, 2.9.11 *has been renumbered* Pt 9, Ch 9, 5.2.24.

~~*2.9.12*~~ *5.2.25* A fire detection alarm system panel in accordance with ~~2.8~~ 4.1 may be used for receiving fire detection signals. Separate loops are not required provided that the address of the initiating device can be identified at the control panel. The received signals are then to be sent to the control panel required by ~~2.9.6~~ 5.2.8 for processing and action.

Existing paragraph Pt 9, Ch 1, 2.9.13 *has been renumbered* Pt 9, Ch 9, 5.2.26.

~~17.4~~ 5.3 Fire pumps

Existing paragraphs Pt 10, Ch 1, 17.4.1 *and* 17.4.2 *have been renumbered* Pt 9, Ch 9, 5.3.1 *and* 5.3.2.

~~17.5~~ 5.4 Refrigerated liquid carbon dioxide systems

Existing paragraphs Pt 10, Ch 1, 17.5.1 *and* 17.5.2 *have been renumbered* Pt 9, Ch 9, 5.4.1 *and* 5.4.2.

~~17.6~~ 5.5 Fire safety stops

Existing paragraphs Pt 10, Ch 1, 17.6.1 *to* 17.6.6 *have been renumbered* Pt 9, Ch 9, 5.5.1 *to* 5.5.6.

~~*17.6.3*~~ *5.5.3* All power ventilation systems, machinery space ventilation, which is to be in accordance with ~~17.6.2~~ 5.5.2 are to be fitted with master controls, with manual reset, so that all fans may be stopped, in the event of fire, from the central control station and from another position situated as far apart as is practicable. Off indication is to be provided for the ventilation fans at the central control station along with provisions to enable them to be reactivated.

Existing paragraph Pt 10, Ch 1, 17.6.4 *has been renumbered* Pt 9, Ch 9, 5.5.4.

~~17.6.5~~ 5.5.5 Fire safety stop systems are to be designed on the fail-safe principle or alternatively the power supplies to, and the circuits of, the fire safety stop systems are to be continuously monitored and an alarm initiated in the event of a fault. Cables are to be of a fire resistant type, *see* ~~11.5.3~~ Ch 3, 8.5.3 and ~~5.2.1~~ Ch 3, 4.2.1.

Existing paragraph Pt 10, Ch 1, 17.6.6 *has been renumbered* Pt 9, Ch 9, 5.5.6.

~~17.7~~ 5.6 Fire doors

Existing paragraphs Pt 10, Ch 1, 17.7.1 *and* 17.7.2 *have been renumbered* Pt 9, Ch 9, 5.6.1 *and* 5.6.2.

~~17.7.1~~ 5.6.1 The electrical power required for the control, indication and alarm circuits of fire doors is to be provided by an emergency source of electrical power as required by ~~3.2~~ Ch 2, 5.2. An alternative supply fed from the main source of electrical power, with automatic change-over facilities, is to be provided at the central control station. Failure of any power supply is to operate an audible and visual alarm, *see also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7 and ~~1.18~~ Ch 1, 2.5.

Existing paragraph Pt 10, Ch 1, 17.7.2 *has been renumbered* Pt 9, Ch 9, 5.6.2.

~~17.8~~ 5.7 Fire dampers

Existing paragraphs Pt 10, Ch 1, 17.8.1 *to* 17.8.3 *have been renumbered* Pt 9, Ch 9, 5.7.1 *to* 5.7.3.

~~17.9~~ 5.8 Fire-extinguishing media release

Existing paragraphs Pt 10, Ch 1, 17.9.1 *and* 17.9.2 *have been renumbered* Pt 9, Ch 9, 5.8.1 *and* 5.8.2.

~~17.9.1~~ 5.8.1 Where it is required that alarms be provided to warn of the release of a fire-extinguishing medium, and these are electrically operated, they are to be provided with an emergency source of electrical power, as required by ~~3.2~~ Ch 2, 5.2, and also connected to the main source of electrical power, with automatic changeover facilities located in, or adjacent to, the fire-extinguishing media release panel, *see also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7. Failure of any power supply is to operate an audible and visual alarm, *see also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7 and ~~1.18~~ Ch 1, 2.5.

~~17.9.2~~ 5.8.2 The arrangements for accessing and activating the release of fire-extinguishing media are not to automatically shut off fuel oil, lubricating oil or hydraulic oil to machinery essential for the propulsion and the safety of the ship, *see* ~~1.6.1~~ Pt 1, Ch 1, 3.1.5.

~~19.1~~ 5.9 Watertight doors

Existing paragraphs Pt 10, Ch 1, 19.1.1 *to* 19.1.14 *have been renumbered* Pt 9, Ch 9, 5.9.1 *to* 5.9.14.

~~19.1.1~~ 5.9.1 The electrical power required for power-operated sliding watertight doors is to be separate from any other power circuit and supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits are to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by the transitional source of emergency electrical power required by ~~3.2.6~~ Ch 2, 5.2.6 in the event of failure of either the main or emergency source of electrical power.

Existing paragraphs Pt 10, Ch 1, 19.1.2 *to* 19.1.14 *have been renumbered* Pt 9, Ch 9, 5.9.2 *to* 5.9.14.

~~19.2~~ 5.10 Bow, stern and shell doors, loading doors and other closing appliances

Existing paragraphs Pt 10, Ch 1, 19.2.1 *to* 19.2.3 *have been renumbered* Pt 9, Ch 9, 5.10.1 *to* 5.10.3.

~~19.2.2~~ 5.10.2 Where such doors and appliances are to be operated at sea, the requirements of ~~19.1~~ 5.9 are to be complied with as far as is practicable.

Existing paragraph Pt 10, Ch 1, 19.2.3 *has been renumbered* Pt 9, Ch 9, 5.10.3.

Volume 2, Part 9

Electrotechnical Systems

Chapter 10

Internal Communication

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to the design and construction philosophy for the Internal Communication system.

This Chapter details the requirements for sub-systems and equipment within the boundary of the Internal Communication system.

Approval will be in respect of the integrity of the Internal Communication System (including secondary and emergency communications), communication system configuration, EMC enclosure configuration (where appropriate), control, monitoring, alert and safety systems, and other critical support systems.

The Internal Communication system is to be designed and manufactured in accordance with a relevant International or National Standard acceptable to Lloyd's Register (hereinafter referred to as 'LR').

Application of this Chapter will facilitate the verification of the performance requirements of *ANEP-77 NATO Naval Ship Code*, Chapter VII, Regulation 10 and Chapter VIII, Regulation 7.

■ *Section 1*
Functional requirements

1.1 Functional requirements

1.1.1 A main broadcast system shall enable verbal communication to Persons Onboard of an emergency incident and the actions to be taken.

1.1.2 A General Emergency Alarm System shall enable the notification of all embarked persons in a timely manner that an emergency situation exists.

■ *Section 2*
Performance requirements

2.1 Performance requirements

2.1.1 The main broadcast system shall:

(a) allow one-way verbal communication to Persons Onboard;
(b) be clearly noticeable by all embarked persons;
(c) be easily distinguishable and recognisable;
(d) be continuously available;
(e) be protected from hazards such as fire, vibration, electrical interference or flooding;
(f) be provided such that any incident which may cause alarm failure shall be guarded against by system or equipment redundancy;
(g) be operable from strategic positions and locations used for command and control.

2.1.2 The general emergency alarm shall:

(a) be clearly noticeable by all embarked persons;
(b) be easily distinguishable and recognisable;
(c) be continuously available;
(d) be protected from hazards such as fire, vibration, electrical interference, flooding;
(e) be provided such that any incident which may cause alarm failure shall be guarded against by system or equipment redundancy;
(f) be operable from strategic positions.

2.1.3 Effective means of communicating orders from the conning positions to any position from which the speed and direction of thrust of the propellers can be controlled shall be provided.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 Compliance with the requirements in Sections 4 to 5 inclusive is deemed to satisfy the functional requirements and performance requirements above.

3.1.2 Where a designer offers a novel solution, an engineering safety and justification report is to be submitted. The engineering safety and justification report is to demonstrate how the proposed solution will satisfy the functional requirements and performance requirements in Sections 1 and 2.

3.1.3 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section 4*
Main broadcast

~~18.3~~ 4.1 Crew and embarked personnel address system

Existing paragraphs Pt 10, Ch 1, 18.3.1 *to* 18.3.11 *have been renumbered* Pt 9, Ch 10, 4.1.1 *to* 4.1.11.

~~18.3.2~~ 4.1.2 The crew and embarked personnel address system is to be provided with an emergency source of electrical power as required by ~~3.2~~ Ch 2, 5.2 and also connected to the main source of electrical power with automatic changeover facilities located adjacent to the crew and embarked personnel address system. Failure of any power supply is to operate an audible and visual alarm, *see also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7 and ~~1.18~~ Ch 1, 2.5.

Existing paragraph Pt 10, Ch 1, 18.3.3 *has been renumbered* Pt 9, Ch 10, 4.1.3.

~~18.3.4~~ 4.1.4 The crew and embarked personnel address distribution system is to be so arranged that a fire or casualty in any one main vertical zone, other than the zone in which the crew and embarked personnel address control station is located, will not interfere with the facility to broadcast emergency announcements in any other such zone, *see also* ~~1.17~~ Ch 1, 2.6.

~~18.3.5~~ 4.1.5 There are to be at least two cable routes in each fire zone sufficiently separated throughout their length to crew and embarked personnel rooms, alleyways, stairways, and control stations so arranged that any single electrical fault, localised fire or casualty will not cause the loss of the facility to broadcast emergency announcements in any crew and embarked personnel rooms, alleyways, stairways, and control stations, albeit at a reduced capacity.

Existing paragraphs Pt 10, Ch 1, 18.3.6 *to* 18.3.8 *have been renumbered* Pt 9, Ch 10, 4.1.6 *to* 4.1.8.

~~18.3.9~~ 4.1.9 Where the crew and embarked personnel address system is used for sounding the general emergency alarm and the fire-alarm, the following requirements are to be met in addition to those of ~~18.2~~ Ch 10, 5.1:

(a) The emergency system is given automatic priority over any other system input.
(b) More than one device is provided for generating the sound signals for the emergency alarms.

Existing paragraph Pt 10, Ch 1, 18.3.10 *has been renumbered* Pt 9, Ch 10, 4.1.10.

~~18.3.11~~ 4.1.11 The sound pressure levels are to be measured during a practical test using speech and, where applicable, tone signals and documented, *see* ~~21.2~~ Ch 10, 1.2.

Existing paragraph Pt 10, Ch 1, 1.15. 1 *has been renumbered* Pt 9, Ch 10, 4.1.12.

~~1.15.1~~ 4.1.12 ~~Where alarms are required by this Chapter they are to be arranged in accordance with Pt 9, Ch 1,2.3.~~ Sound signal equipment, fire and general alarm bells are ~~not required~~ to be supplemented by visual indication~~, except~~ in areas having high levels of background noise, such as machinery spaces.

■ *Section 5*
General emergency alarm

~~18.2~~ 5.1 Emergency alarm system

Existing paragraphs Pt 10, Ch 1, 18.2.1 *to* 18.2.6 *have been renumbered* Pt 9, Ch 10, 5.1.1 *to* 5.1.6.

~~18.2.1~~ 5.1.1 An electrically operated bell or klaxon or air-operated whistle with independent air supply or other equivalent warning system installed in addition to the ship's whistle or siren, for sounding the general emergency alarm signal is to comply with the *International Lifesaving-Saving Appliances (LSA) Code* and with the requirements of this Section, *see also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7 and ~~1.18~~ Ch 1, 2.5.

~~18.2.2~~ 5.1.2 The general emergency alarm system is to be provided with an emergency source of electrical power as required by ~~3.2 or 3.3~~ Ch 2, 5.2 and 5.3 and also connected to the main source of electrical power with automatic changeover facilities located in, or adjacent to, the main alarm signal distribution panel. Failure of any power supply is to operate an audible and visual alarm, *see also* ~~1.15~~ Ch 3, 8.10.6 and 8.10.7.

Existing paragraphs Pt 10, Ch 1, 18.2.3 *to* 18.2.5 *have been renumbered* Pt 9, Ch 10, 5.1.3 *to* 5.1.5.

~~18.2.6~~ 5.1.6 The sound pressure levels are to be measured during a practical test and documented, *see* ~~21.2~~ Ch 10, 2.1.

Existing paragraph Pt 10, Ch 1, 1.15. 1 *has been renumbered* Pt 9, Ch 10, 5.1.7.

~~1.15.1~~ 5.1.7 ~~Where alarms are required by this Chapter they are to be arranged in accordance with Pt 9, Ch 1,2.3.~~ Sound signal equipment, fire and general alarm bells are ~~not required~~ to be supplemented by visual indication~~, except~~ in areas having high levels of background noise, such as machinery spaces.

■ *Section 6*
Two-way communication

6.1.1 Two-way communication is to be provided at key locations as defined by the Naval Administration.

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Electrotechnical Systems

Chapter 11

Testing and Trials

Effective Date 1 January 2015

■ *Section ~~21~~ 1*
Testing and trials

Existing paragraphs Pt 10, Ch 1, 21.1.1 *to* 21.1.5 *have been renumbered* Pt 9, Ch 11, 1.1.1 *to* 1.1.5.

~~21.1~~ 1.1 Testing

~~21.1.1~~ 1.1.1 Tests in accordance with ~~21.1.2 to 21.1.4~~ 1.1.2 to 1.1.4 are to be satisfactorily carried out on all electrical equipment, complete or in sections, at the manufacturer's premises and a test report issued by the manufacturer.

~~21.1.2~~ 1.1.2 A high voltage at any frequency between 25 and 100 Hz is to be applied between:
(a) all current carrying parts connected together and earth;
(b) all current carrying parts of opposite polarity or phase.
For rotating machines, the value of test voltage is to be 1000 V plus 2 x rated voltage with a minimum of 2000 V, and for other electrical equipment, it is to be in accordance with Table ~~1.21.1~~ 11.1.1. Items of equipment included in the assembly for which a test voltage lower than the above is specified may be disconnected during the test and tested separately at the appropriate lower test voltage. The test is to be commenced at a voltage of about one third the test voltage and is to be increased to full value as rapidly as is consistent with its value being indicated by the measuring instrument. The full test voltage is then to be maintained for 1 minute, and then reduced to one third full value before switching off. The assembly is considered to have passed the test if no disruptive discharge occurs.

Existing paragraph Pt 10, Ch 1, 21.1.3 *has been renumbered* Pt 9, Ch 11, 1.1.3.

Table ~~1.21.1~~ 11.1.1 Test voltage

~~21.1.4~~ 1.1.4 Immediately after the high voltage test, the insulation resistance is to be measured using a direct current insulation tester, between:
(a) all current carrying parts connected together and earth;
(b) all current carrying parts of different polarity or phase.
The minimum values of test voltage and insulation resistance are given in Table ~~1.21.2~~ 11.1.2.

Table ~~1.21.2~~ 11.1.2 Test voltage and minimum insulation

Existing paragraph Pt 10, Ch 1, 21.1.5 *has been renumbered* Pt 9, Ch 11, 1.1.5.

~~21.2~~ 1.2 Trials

Existing paragraph Pt 9, Ch 1, 7.1.1 *has been included in* Pt 9, Ch 11, 1.2.1.

~~7.1.1 Before a new installation (or any alteration or addition to an existing installation) is put into service, trials are to be carried out. These trials are in addition to any acceptance tests which may have been carried out at the manufacturers' works and are to be based on the approved test schedules list as required by 1.2.3. In the case of new construction it will be expected that most of these trials will be carried out before the official sea trials of the ship. During sea trials, system dynamic tests are to be carried out to demonstrate overall satisfactory performance of the control engineering installation.~~

Existing paragraph Pt 10, Ch 1, 21.2.1 *has been renumbered* Pt 9, Ch 11, 1.2.1.

~~21.2.1~~ 1.2.1 Before a new installation, or any alteration or addition to an existing installation, is put into service the applicable trials in ~~21.2.2 to 21.2.7~~ 1.2.2 to 1.2.7 are to be carried out. These trials are in addition to any acceptance tests which may have been carried out at the manufacturer's works and are to be to the Surveyor's satisfaction. A report having the results of measurements taken during the trials is to be submitted for record purposes. In the case of new construction it will be expected that most of these trials will be carried out before the official sea trials of the ship. During sea trials, system dynamic tests are to be carried out to demonstrate overall satisfactory performance of the control engineering installation.

Existing paragraphs Pt 9, Ch 1, 7.1.2 *to* 7.1.4 *have been renumbered* Pt 9, Ch 11, 1.2.2 *to* 1.2.4.

~~7.1.3~~ 1.2.3 Acceptance tests and trials for Programmable Electronic Systems are to include verification of software lifecycle activities appropriate to the stage in the system's lifecycle at the time of system examination. The documentation required by ~~1.2.6~~ Ch 1, 1.4.8 is to be in accordance with the current configuration and the testing and trials are to address software modifications to the Surveyor's satisfaction.

Existing paragraph Pt 10, Ch 1, 21.2.2 *to* 21.2.8 *have been renumbered* Pt 9, Ch 11, 1.2.5 *to* 1.2.11.

~~21.2.2~~ 1.2.5 The insulation resistance is to be measured of all circuits and electrical equipment, using a direct current insulation tester, between:
(a) all current carrying parts connected together and earth and, so far as is reasonably practicable;
(b) all current carrying parts of different polarity or phase;
The minimum values of test voltage and insulation resistance are given in Table ~~1.21.2~~ 11.1.2.

The installation may be subdivided and appliances may be disconnected if initial tests produce results less than these figures.

~~*21.2.3*~~ *1.2.6* Tests are to be made to verify the effectiveness of:

(a) earth continuity conductor;
(b) the earthing of non-current carrying exposed metal parts of electrical equipment and cables not exempted by ~~1.13.2~~ Ch 1, 2.4.2;
(c) bonding for the control of static electricity.

Existing paragraph Pt 10, Ch 1, 21.2.4 *has been renumbered* Pt 9, Ch 11, 1.2.7.

~~*21.2.5*~~ *1.2.8* Measurements are to be taken as part of the trials specified in ~~21.2.4~~ 1.2.4 (c), (d), (e) and (f) to verify that the installation will provide a quality of power supply in accordance with the values listed in ~~1.8~~ Ch 1, 2.1.

~~*21.2.6*~~ *1.2.9* In addition to ~~21.2.5~~ 1.2.5, unless it has been satisfactorily shown by the design verification and validation process required by 1.9.5, that the power supply quality complies with the requirements of the ~~defined~~ specified standard, then compliance is to be demonstrated by measurements taken at ~~the~~ representative ship operating loads, as defined by the ~~Naval Authority~~ Naval Administration, *see* ~~1.9.1~~ Ch 1, 3.1.1.

Existing paragraphs Pt 10, Ch 1, 21.2.7 *and* 21.2.8 *have been renumbered* Pt 9, Ch 11, 1.2.10 *and* 1.2.11.

~~21.3~~ 1.3 High voltage cables

Existing paragraph Pt 10, Ch 1, 21.3.1 *to* 21.3.3 *have been renumbered* Pt 9, Ch 11, 1.3.1 *to* 1.3.3.

~~*21.3.1*~~ *1.3.1* Before a new high voltage cable installation, or an addition to an existing installation, is put into service, a voltage withstand test is to be satisfactorily carried out on each completed cable and its accessories. The test is to be carried out after the insulation resistance test required by ~~21.2.2~~ 1.2.2 and may use either an a.c. voltage at power frequency or a d.c. voltage.

Existing paragraph Pt 10, Ch 1, 21.3.2 *has been renumbered* Pt 9, Ch 11, 1.3.2.

~~*21.3.3*~~ *1.3.3* When a d.c. voltage withstand test is carried out, the voltage is to be not less than:

(a) 1,6 (2,5U_O + 2 kV) for cables of rated voltages (U_O) up to and including 3,6 kV; or
(b) 4,2U_O for higher rated voltages where U_O is the rated power frequency voltage between conductor and earth or metallic screen, for which the cable is designed.
The test voltage is to be maintained for a minimum of 15 minutes. After completion of the test the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge. An insulation resistance test in accordance with ~~21.2.2~~ 1.2.2 is then to be repeated.

~~21.4~~ 1.4 Hazardous areas

Existing paragraphs Pt 10, Ch1, 21.4.1 *and* 21.4.2 *have been renumbered* Pt 9, Ch 11, 1.4.1 *and* 1.4.2.

Existing sub-Sections Pt 9, Ch 1, 7.2, 7.3, 7.4 *and* 7.5 *have been renumbered* Pt 9, Ch 11, 1.5, 1.6, 1.7 *and* 1.8.

~~7.2~~ 1.5 Unattended machinery space operation – UMS notation

~~*7.2.1*~~ *1.5.1* In addition to the tests required by ~~6.1~~ Ch 7 the suitability of the installation for operation in the unattended mode is to be demonstrated during sea trials observing the following:

(a) Occurring alarms and the frequency of operation both during steady steaming and under manoeuvring conditions using bridge control.
(b) Any intervention by personnel in the operation of the machinery.

~~7.3~~ 1.6 Operation from a centralised control station – CCS notation

~~*7.3.1*~~ *1.6.1* In addition to the tests required by ~~7.1~~ Ch 7, the suitability of the installation for operation from the centralised control station is to be demonstrated during sea trials.

~~7.4~~ 1.7 Integrated platform management system failure

~~*7.4.1*~~ *1.7.1* Where mobility type ship systems are operated through an Integrated Platform Management System (~~IMPS~~ IPMS), a failure in the ~~IMPS~~ IPMS is not to render the ship's system inoperable. ~~and reversionary~~ Reversionary modes of operation are to be provided to ensure safe and graceful degradation ~~and~~ under these conditions ~~any level~~. The Systems Design Description shall define the acceptable levels of degraded performance. ~~should be defined and accepted by the Naval Authority.~~

~~7.5~~ 1.8 Record of trials

~~*7.5.1*~~ *1.8.1* Two copies of the alarm and control equiment test schedules, as required by ~~1.2.3~~ Ch 1, 1.4.25, signed by the Surveyor and Builder are to be provided on completion of the survey. One copy is to be placed on board the vessel and the other submitted to LR.

Volume 2, Part 10

~~Electrical Engineering~~

Human Factors

Chapter 1

~~Electrical Engineering~~

Ergonomics

Effective Date 1 January 2015

■ *Scope*

The requirements of this Chapter are applicable to incorporate principles of human-centred design and ergonomics in the design and construction philosophy of control stations and ship-board lighting systems.

The requirements of this Chapter focus on the hazard associated with personnel at control stations and the related physical hazards and general and task lighting. Additionally a broader set of issues related to the cognitive aspects of control station design for both traditional and computer-based control is provided.

Application of this Chapter will facilitate the verification of the functional objectives and performance requirements of *ANEP-77 NATO Naval Ship Code*, Chapter IV, Regulation 17.

■ *Section 1*
Functional requirements

1.1 Functional requirements

1.1.1 Physical arrangements for machinery and equipment shall not pose a risk to personnel.

1.1.2 Information relating to the operation of the equipment shall not result in unintended actions.

■ *Section 2*
Performance requirements

2.1 Performance requirements

2.1.1 The following areas are to be designed with consideration to the human element:

(a) the Navigation Bridge;
(b) the main machinery control position; and
(c) other conning and control positions as agreed with the Naval Administration.

2.1.2 The layout of control positions is to enhance usability and reduce human error in Operators’ tasks.

2.1.3 The working environment is to be designed to be safe, have the minimum of distractions, be sufficiently comfortable, help to maintain vigilance, and maximise communication amongst Operators at main control stations.

2.1.4 User interfaces are to be designed to enhance the usability of systems and equipment, reduce human error, enhance situational awareness, and support safe and effective monitoring and control under normal and foreseeably abnormal modes of operation.

2.1.5 The design of lighting is to facilitate visual task performance, Operator safety and visual comfort.

■ *Section 3*
Verification requirements

3.1 General

3.1.1 An engineering safety and justification report is to be submitted to demonstrate the design incorporates the requirements of Sections 1, 2, 4, 5 and 6.

3.1.2 The Naval Administration may impose requirements additional to those in this Chapter.

■ *Section 4*
Particulars to be submitted

4.1 Particulars to be submitted

Sentences of existing paragraph Pt 9, Ch 1, 1.2.8 *have been renumbered* Pt 10, Ch 1, 4.4.1 *to* 4.4.4.

~~*1.2.8* Plans showing the location and details of control stations, e.g., control panels and consoles. Location and details of controls and displays on each panel. Detailed user interface speficiations. A general arrangement plan of control rooms showing the position of consoles, handrails, operator area, lighting , door and window arrangements. Drawing of HVAC systems including vent arrangements.~~

4.4.1 Plans showing the location and details of control stations, e.g. control panels and consoles, location and details of controls and displays on each panel.

4.4.2 Details of user interface specifications.

4.4.3 A general arrangement plan of control rooms showing the position of consoles, handrails, operator area, lighting, door and window arrangements.

4.4.4 Drawing of HVAC systems including vent arrangements.

4.4.5 A general arrangement plan for the ship showing lighting and window arrangements.

■ Section ~~3~~ 5

Ergonomics of control stations

~~3.1 Objectives~~

~~3.2~~ 5.1 Control station layout

Existing paragraphs Pt 9, Ch 1, 3.1.1, 3.2.1 *to* 3.2.12 *have been renumbered* Pt 10, Ch 1, 5.1.1, 1.5.1.2 *to* 5.1.13.

~~3.1.1~~ 5.1.1 In order to ~~take account of~~ support operator tasks at control stations, enhance usability and reduce human error, the layout arrangements are to comply with the requirements set out in ~~3.2~~ 5.1.2 to 5.1.13.

~~3.2.1~~ 5.1.2 Control stations are to provide sufficient space and access for the intended number of ~~operators~~ Operators in the expected operating conditions.

~~3.2.2~~ 5.1.3 Local control stations are to be positioned to minimise the risk of harm to the ~~operator~~ Operator.

Existing paragraphs Pt 9, Ch 1, 3.2.3 *and* 3.2.4 *have been renumbered* Pt 10, Ch 1, 5.1.4 *and* 5.1.5.

~~3.2.5~~ 5.1.6 Frequently used controls and displays are to be within easy reach and visible to the ~~operator~~ Operator from the normal working position.

Existing paragraphs Pt 9, Ch 1, 3.2.6 *to* 3.2.11 *have been renumbered* Pt 10, Ch 1, 5.1.7 *to* 5.1.12.

~~3.2.12~~ 5.1.13 Instruments are to face the ~~operator's~~ Operator's intended working position.

~~3.3~~ 5.2 Physical environment

Existing paragraphs Pt 9, Ch 1, 3.1.2 *and* 3.3.1 *to* 3.3.5 *have been renumbered* Pt 10, Ch 1, 5.2.1 *to* 5.2.6.

~~3.1.2~~ 5.2.1 In order to establish a working environment that has minimum distractions, is sufficiently comfortable, helps maintain vigilance and maximises communication amongst ~~operators~~ Operators at main control stations, the requirements of ~~3.3~~ 5.2.2 to 5.2.12 are to be complied with.

Existing paragraphs Pt 9, Ch 1, 3.3.1 *has been renumbered* Pt 10, Ch 1, 5.2.2.

~~3.3.2~~ 5.2.3 In general, noise levels are to comply with IMO ~~Res. A.468 (XII)~~ Resolution MSC.337(91), *Code on Noise Levels On Board Ships*, and take into account IMO Res. A.343(IX)~~,~~: *Recommendation on Methods of Measuring Noise. Levels at Listening Posts*.

Existing paragraphs Pt 9, Ch 1, 3.3.3 *and* 3.3.4 *have been renumbered* Pt 10, Ch 1, 5.2.4 *and* 5.2.5.

~~3.3.5~~ 5.2.6 The flow of air from heating or air-conditioning systems is not to be guided directly to the ~~operator~~ Operator, or means are to be provided to adjust the direction of air flow from those systems.

~~3.3.7~~ 5.2.7 Placement of controls, displays and indicators are to consider the position of light sources relative to the ~~operator~~ Operator with respect to reflections and evenness of lighting.

~~3.3.9~~ 5.2.8 The level of lighting is to be sufficient to enable operation of user interfaces. Lighting levels in accordance with Table ~~1.3.1~~ 1.5.1 will be considered to satisfy this requirement. Section 6 contains further requirements on internal and task lighting for the ship.

Table ~~1.3.1~~ 1.5.1 Specific lighting levels

~~3.3.11~~ 5.2.9 Seating provided for use at control stations is to allow for varying height and/or reach needs of ~~operators~~ Operators. Seating arrangements are to minimise the need for twisting and/or turning motions by the ~~operator~~ Operator.

~~3.3.12~~ 5.2.10 Physical hazards, ~~e.g.,~~ such as sharp edges, protuberances and trip hazards, are to be avoided.

~~3.3.13~~ 5.2.11 Sufficient hand-rails or equivalent are to be fitted to enable ~~operators~~ Operators to move and stand safely in rough seas.

Existing paragraph Pt 9, Ch 1, 3.3.14 *has been renumbered* Pt 10, Ch 1, 5.2.12.

~~3.4~~ 5.3 Operator interface

Existing paragraph Pt 9, Ch 1, 3.1.3 *has been renumbered* Pt 10, Ch 1, 5.3.1.

~~3.1.3~~ 5.3.1 The requirements of ~~3.4 to 3.6~~ 5.3.2 to 5.3.7 apply to operator interfaces for essential engineering systems located either locally, remotely or within the main control room. The requirements are intended to enhance the usability of systems and equipment, reduce human error, enhance situational awareness and support safe and effective monitoring and control under normal and abnormal modes of operation.

Existing paragraph Pt 9, Ch 1, 3.4.1 *has been renumbered* Pt 10, Ch 1, 5.3.2.

~~3.4.2~~ 5.3.3 Information is to be presented to the ~~operator~~ Operator consistently both within and between different interfaces, *see* ~~3.6.2 to 3.6.4~~ 5.5.3 to 5.5.5.

Existing paragraphs Pt 9, Ch 1, 3.4.3 *and* 3.4.4 *have been renumbered* Pt 10, Ch 1, 5.3.4 *and* 5.3.5.

~~3.4.5~~ 5.3.6 Functions requested by the ~~operator~~ Operator are to be confirmed by the displays on completion.

Existing paragraph Pt 9, Ch 1, 3.4.6 *has been renumbered* Pt 10, Ch 1, 5.3.7.

~~3.5~~ 5.4 Controls

Existing paragraph Pt 9, Ch 1, 3.1.3 *has been renumbered* Pt 10, Ch 1, 5.4.1.

~~3.1.3~~ 5.4.1 The requirements of ~~3.4 to 3.6~~ 5.4.2 to 5.4.13 apply to operator interfaces for essential engineering systems located either locally, remotely or within the main control room. The requirements are intended to enhance the usability of systems and equipment, reduce human error, enhance situational awareness and support safe and effective monitoring and control under normal and abnormal modes of operation.

Existing paragraphs Pt 9, Ch 1, 3.5.1 *to* 3.5.12 *have been renumbered* Pt 10, Ch 1, 5.4.2 *to* 5.4.13.

~~3.5.1~~ 5.4.2 Operator inputs are to be checked for errors, for example, out of range data or incorrect actions, and alert the ~~operator~~ Operator when they occur.

Existing paragraph Pt 9, Ch 1, 3.5.2 *has been renumbered* Pt 10, Ch 1, 5.4.3.

~~3.5.3~~ 5.4.4 Assistance is to be provided to the ~~operator~~ Operator to recover from operator errors, for example, through advisory screens where the automation system has this facility.

Existing paragraphs Pt 9, Ch 1, 3.5.4 *to* 3.5.12 *have been renumbered* Pt 10, Ch 1, 5.4.5 *to* 5.4.13.

~~3.6~~ 5.5 Displays

Existing paragraph Pt 9, Ch 1, 3.1.3 *has been renumbered* Pt 10, Ch 1, 5.5.1.

~~3.1.3~~ 5.5.1 The requirements of ~~3.4 to 3.6~~ 5.5.2 to 5.5.16 apply to operator interfaces for essential engineering systems located either locally, remotely or within the main control room. The requirements are intended to enhance the usability of systems and equipment, reduce human error, enhance situational awareness and support safe and effective monitoring and control under normal and abnormal modes of operation.

Existing paragraphs Pt 9, Ch 1, 3.6.1 *to* 3.6.15 *have been renumbered* 5.5.2 *to* 5.5.16.

~~3.6.1~~ 5.5.2 The displays and indicators are to present the ~~operator~~ Operator with clear, timely and relevant information.

~~3.6.2~~ 5.5.3 Graphical symbols and colour coding are to be consistent. The graphical symbols of display functions are to be in accordance with a recognised ~~international standard~~ International Standard, for example, ISO 14617~~,~~ (all parts): *Graphical symbols for diagrams*. Colour coding of functions and signals is to be in accordance with a recognised ~~international standard~~ International Standard, for example, ISO 2412:~~1982,~~: *Shipbuilding – Colours of indicator lights*.

~~3.6.3~~ 5.5.4 The symbols used in mimic diagrams for the services listed in ~~Pt 10, Ch 1,1.5.1~~ Pt 1, Ch 1, 3.1.5, 3.1.6 and 3.1.7 are to be consistent across all displays.

Existing paragraphs Pt 9, Ch 1, 3.6.4 *to* 3.6.11 *have been renumbered* Pt 10, Ch 1, 5.5.5 *to* 5.5.12.

~~3.6.12~~ 5.5.13 Alphanumeric data, text, symbols and other graphical information is to be readable from relevant operator positions under lighting conditions as specified in ~~3.3.9~~ 6.2.1.9. Character height in millimetres is to be not less than three and a half times the reading distance in metres and character width is to be 0,7 times the character height.

Existing paragraph Pt 9, Ch 1, 3.6.13 *has been renumbered* Pt 10, Ch 1, 5.5.14.

~~3.6.14~~ 5.5.15 Where information related to the safe operation of machinery and equipment is provided, it is to be continuously available to the ~~operator~~ Operator.

~~3.6.15~~ 5.5.16 Failures are to be indicated in a clear and unambiguous manner. Sufficient information is to be provided for the ~~operator~~ Operator to identify the cause of the failure.

■ *Section 6*
Ergonomics of lighting

6.1 Positioning and installation

6.1.1 In order to meet the ergonomic requirements of 6.2 to 6.5 the positioning and installation of lights are to comply with 6.1.2 to 6.1.11.

6.1.2 Natural lighting through the use of windows and doors is to be provided as far as practicable.

6.1.3 Lights are to be positioned, as far as practicable, in the same horizontal plane and arranged symmetrically to produce a uniform level of illumination.

6.1.4 Lights are to be positioned taking account of air-conditioning vents or fans, fire detectors, water sprinklers, etc., so the lighting is not blocked by these items.

6.1.5 Lights are to be positioned taking account of structures such as beams and columns etc., so the lighting is not blocked by these items.

6.1.6 Lights are to be positioned so as to reduce bright spots and shadows as far as possible.

6.1.7 The positioning of fluorescent tubes is to be at right angles to an Operator's line of sight while the Operator is located at their typical duty station as far as practicable.

6.1.8 Any physical hazards that provide a risk to operator safety are to be appropriately illuminated.

6.1.9 The positioning of lights is to consider the transfer of heat to adjacent surfaces.

6.1.10 Lights are not to be positioned in locations which would result in a significant reduction in illumination.

6.1.11 Lights are not to be positioned in locations that are difficult to reach for bulb replacement or maintenance.

6.2 Illuminance distribution

6.2.1 In order to provide even, fatigue-free illumination the requirements of 6.3.2 to 6.3.6 are to be complied with.

6.2.2 The light levels falling on the plane in which a task is performed, are to be suitable for the type of task, i.e. they are to consider the variation in the working planes.

6.2.3 Sharp contrasts in illumination levels across an operator task or working plane are to be avoided, as far as possible.

6.2.4 Sharp contrasts in illumination levels between an operator task area and the immediate surround and general background area are to be avoided, as far as possible.

6.2.5 Where required, local lighting is to be provided in addition to general lighting for operational tasks.

6.2.6 Lighting is to be free of perceived flicker.

6.3 Glare

6.3.1 In order to minimise glare, the requirements of 6.3.2 to 6.3.6 are to be complied with.

6.3.2 Lights are to be positioned so as to reduce as far as possible glare or high brightness reflections from working and display surfaces.

6.3.3 Where necessary, suitable blinds and shading devices are to be used to prevent glare.

6.3.4 The placement of controls, displays and indicators are to consider the position of lights relative to the Operator, in their normal working position, with respect to reflections and evenness of lighting.

6.3.5 Surfaces are to have a non-reflective or matt finish in order to reduce the likelihood of indirect glare.

6.3.6 Where a transparent cover is fitted over a control, display or indicator, it is to be designed to minimise reflections.

6.4 Location of lighting controls and outlets

6.4.1 In order to allow convenient use of lighting the requirements of 6.4.2 to 6.4.4 are to be complied with.

6.4.2 The lighting system is to be easily maintainable and operable by personnel.

6.4.3 Lighting is to be controllable locally.

6.4.4 Light switches are to be fitted in positions which are safe for personnel.

6.4.5 The mounting height of switches is to be such that personnel can reach switches with ease.

6.4.6 Power outlets are to be provided for temporary local lighting, for example in accommodation areas, work spaces and internal and external walkways.

6.5 Night vision

6.5.1 In order to maintain night vision and facilitate safety during hours of darkness, the requirements of 6.5.2 and 6.5.8 are to be complied with.

6.5.2 A satisfactory level of lighting is to be available to enable members of the bridge team to complete such tasks as chart work at sea, and maintenance and ship management in port, by daylight or darkness.

6.5.3 A satisfactory level of flexibility within the lighting system is to be available to enable members of the bridge team to adjust the lighting in brightness and direction as required in different areas of the bridge and by individual user interface devices.

6.5.4 During hours of darkness it is to be possible for bridge personnel to discern equipment on the bridge so that they can move about and locate equipment.

6.5.5 Red or low intensity light is to be used to maintain dark adaptation whenever possible in areas or on items of equipment, other than the chart table, requiring illumination in the operational mode. This is to include equipment in the bridge wings.

6.5.6 Indirect low level red or low intensity lighting is to be available at deck level, especially for internal doors and staircases. Provision is to be made to prevent red lights from being seen from outside the ship.

6.5.7 Instrument lighting in specified areas is to be such that duty personnel can read off dials and indicators without impediment of night vision.

6.5.8 All illumination and lighting of instruments, keyboards and controls are to be adjustable down to zero, except the lighting of alarm and warning indicators and the controls of dimmers which are to remain readable.

Volume 2, Part 11, Chapter 1
Made and Fresh Water Systems

Effective Date 1 January 2015

■ *Section 1*
General requirements

1.1 General

~~1.1.3~~ ~~The Naval Authority may impose requirements additional to those in this Chapter.~~

1.2 Scope

1.2.2 Where the Owner~~/Operator~~ requires the capability of the made and fresh water systems for purposes other than those listed in 1.2.1 (e.g., engine and aircraft washing), the Owner~~/Operator~~ is responsible for defining the requirements for quality and quantity capabilities.

1.3 ~~Plans and information~~ Documentation required for design review

1.3.2 ~~Design statement.~~ System Design Description. A ~~design statement~~ System Design Description of the made and fresh water system. *See* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5 and 3.1.1, 3.2.2, 3.2.3, 3.3.2, 3.4.2, 3.4.6 and 5.3.1 for specific references to the ~~design statement~~ System Design Description.

■ *Section 2*
System construction and installation

2.3 Piping and equipment – Selection and installation

2.3.1 Pressurised tanks are to be in accordance with the requirements of Pt 8, Ch 2 ~~satisfy the Naval Authority's revalidation system for such items where applicable~~.

2.6 Coating of storage tanks and piping internal surfaces

2.6.2 Corrosion control coatings are to be tested and certified as complying with standards specified by the Designer and ~~agreed by the Naval Authority~~ Owner.

■ *Section 3*
System arrangements

3.1 Water storage facilities

3.1.1 Sufficient potable water storage is to be provided to cater for the needs of the full ship's complement and embarked personnel recognising the operating role of the ship that is to be declared in the ~~design statement~~ System Design Description required by 1.3.2. For example, a ship may be expected to spend some time in littoral waters where production of fresh water using installed plant may not be possible due to plant limitations or statutory regulations. The combination of storage, water production rate and usage is to be carefully considered in the vessel design, taking into account both average and peak loadings, the latter of which may be typically three times the normal usage rate.

3.1.8 Where ~~required by the Naval Authority~~ specified, separate storage tank(s) in addition to the two storage tanks required by 3.1.2 is/are to be provided. The tank(s) is/are to be provided with means for treatment of water in the tank for decontamination or other purposes that may be specified by the ~~Naval Authority~~ Owner.

3.2 Made water production facilities

3.2.1 Made water production facilities fitted are to be capable of producing water to World Health Organisation *Guidelines for Drinking Water Quality, Volume 1 Recommendations Second Edition 1994* as a minimum requirement. A more stringent quality of water production may be necessary in the case of water for use in, for example, boiler feed systems. In these cases, an alternative means of water production is to be provided or a further stage of desalination included in the production arrangements. Where the ~~required~~ specified standards for made water are other than the World Health Organisation Standards, these are to be ~~stated by the Naval Authority~~ provided to LR.

3.2.2 The total capacity of the fresh water generation plant will depend upon a number of parameters including complement, ship operating profile and other equipment supplied, but typically will be of the order of 135 litres/man/day plus 450 litres/aircraft/day. The capacity of the plant and tank storage is to be ~~agreed between~~ specified by the ~~Designer/~~Owner~~/Operator~~ and declared in the ~~design statement~~ System Design Description required by 1.3.2.

3.2.3 Two or more plants for making water are to be provided, of sufficient combined capacity to produce sufficient water under defined levels of requirements stated in the ~~design statement~~ System Design Description required by 1.3.2. Provision of single plant will be considered in conjunction with the operational requirements of the ~~Naval Authority~~ ship and any assigned service restriction.

3.3 Piping system design

3.3.2 The design of piping systems is to recognise operational and manning philosophy for the vessel and is to be declared in the ~~design statement~~ System Design Description required by 1.3.2.

3.4 Piping system distribution

3.4.2 The water distribution system is to be capable of providing a steady flow of water at any point in the system in accordance with the ~~design statement~~ System Design Description required by 1.3.2. Where a pneumatically pressurised tank arrangement is used, the tank is to be provided with water level indication and a means of indicating the pressure. The compressed air connection to the pressurised tank is to incorporate a non-return valve arrangement at the tank to prevent the possibility of water entering the compressed air system and it is recommended that the connection be made via a portable hose connection.

3.4.6 Provision is to be made to connect an alternative source of water supply to defined services in emergency/action damage conditions. For example, where the fresh water main is unavailable, stand-by arrangements are to be provided for suitable water supplies to medical spaces, galleys, bridge window sprays, cleansing stations (CBRN Protection fitted vessels) and weapon cooling. The supply arrangements to defined services in emergency/action damage conditions are to be included in the ~~design statement~~ System Design Description required by 1.3.2 and agreed by the Owner~~/Operator~~.

■ *Section 5*
Testing and Trials

5.3 Trials

5.3.1 Trials are to be carried out to demonstrate that the capability of the production, storage and distribution systems for made and fresh water systems meet the ~~design statement~~ System Design Description. The trials are as far as practicable to be representative of the actual conditions to be encountered in service.

Volume 2, Part 11, Chapter 2
Heating, Ventilation and Cooling Arrangements

Effective Date 1 January 2015

Section 1
General requirements

1.1 General

~~*1.1.3* The Naval Authority may impose requirements additional to those in this Chapter.~~

1.3 ~~Plans and information~~ Documentation required for design review

1.3.2 **~~Design statement.~~ System Design Description**. A ~~design statement~~ System Design Description of the HVAC systems. *See* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5 and 2.4.1, 2.5.1, 2.6.1, 3.1.2(d), 3.1.4, 3.3.1, 3.6.1 and 5.3.1 for specific references to the ~~design statement~~ System Design Description.

Section 2
Construction and installation

2.2 Equipment – Selection and installation

2.2.1 Pressure vessels in heat exchange systems are to be in accordance with Pt 8, Ch 2 or a recognised code ~~and satisfy the Naval Authority's revalidation system for such items where applicable~~.

2.4 Refrigerant systems for cooling

2.4.1 Where chilled water systems complying with Pt 7, Ch 5 are not used for cooling ventilation air, independent refrigeration plants are to be provided and designed to be capable of extracting a defined heat load duty when operating at the conditions stated in the ~~design statement~~ System Design Description required by 1.3.2. Independent refrigeration plants are to comply with the requirements of this Chapter.

2.4.9 Sea water systems for refrigeration condensers are to be capable of being supplied from not less than two independent sources. If required by the ~~Naval Authority~~ System Design Description, these sources are to be located in separate compartments and zones such that the loss of one zone or compartment will not result in the loss of all sea water supply sources.

2.4.10 The capacity of each source of seawater required by 2.4.9 is to be sufficient for the conditions stated in the ~~design statement~~ System Design Description with any one source out of action.

2.5 Heating plant

2.5.1 Independent means of heating the air supplies to ventilation systems for crew and embarked personnel are to be designed to be capable of transferring a defined heat load duty when operating at the conditions stated in the ~~design statement~~ System Design Description required by 1.3.2.

2.6 Filtration units for air intakes

2.6.1 Air inlets and outlets to all ventilation systems are to be provided with suitable protection screens. Filtration units are to be provided at all inlets to air supplies to ventilation systems for crew and embarked personnel in accordance with the conditions stated in the ~~design statement~~ System Design Description.

Section 3
System arrangements

3.1 General

3.1.1 The design of air-conditioning and ventilation systems is to reflect the total ship design including any requirements of the ~~CBRN Protection requirements, fire/damage zoning~~ System Design Description, specified subdivision and stability standard, fire safety standard or other particular features stipulated in the ~~Naval Authority specification for the vessel~~ standards specified for the ship.

(*Part only shown*)

3.1.2 The design and capability of supply and exhaust systems for ventilation purposes are to address the following requirements as applicable:

(a) Noxious odours, toxic and dangerous fumes or other contaminants are to be extracted, taking into account any requirements of the ~~Naval Authority~~ CBRN System Design Description.

(b) Acceptable levels of fresh air are to be provided for personnel efficiency, combustion or other oxidation processes. The arrangements are to ensure that maximum CO_2 levels are not exceeded in all spaces where crew and embarked personnel are likely to be. ~~Unless specified by the Naval Authority:~~

(d) Acceptable internal ambient conditions are to be maintained for personnel comfort in manned compartments and in other compartments where required for equipment cooling. The arrangements for maintaining acceptable ambient conditions are to take account of the range of climatic conditions that the ship is required to operate within and are to be included in the ~~design statement~~ System Design Description required by 1.3.2.

3.1.4 Exhausts from sewage treatment spaces are normally to be led to atmosphere. Where identified in the ~~design statement~~ System Design Description, exhausts may be led to the ship's recirculation system but means of isolation to the recirculation system with alternative exhaust to atmosphere arrangements are to be provided to cater for abnormal plant conditions.

3.3 Galleys

3.3.1 The following arrangements are to be incorporated in ventilation systems within galleys:

(a) All trunking is to be of steel or stainless steel.
(b) Exhaust terminals above equipment such as fryers, grills, etc, are to be fitted with grease filters that can easily be removed and cleaned.
(c) Exhaust branches, fitted with grease filters, are to be protected by fire flaps within the galley. The flaps are to be sited in the exhaust trunking between the canopy and the exit from the galley, arranged to close in the direction of air flow and be readily operable from both within and outside the galley.
(d) CO_2 injection or other fire extinguishing means facilities are to be fitted.

Exhaust systems from galleys are normally to be led to atmosphere. In the case of ships fitted with CBRN Protection and when identified in the ~~design statement~~ System Design Description, the galley ventilation system may be designed to recirculate air and, to limit food smells, odour filtration is to be provided. If the exhaust is led to atmosphere in ships fitted with CBRN Protection, the air loss is to be considered when assessing the CBRN arrangements.

3.6 Smoke clearance

3.6.1 In addition to the requirements in 3.1 to 3.5, ~~the Naval Authority may also require~~ where the Owner has specified the installation of a smoke clearance system. The design of such a system is to be based on the declared operating philosophy identified in the ~~design statement~~ System Design Description required by 1.3.2 which, in general, should recognise that smoke clearance is only undertaken when a fire has been extinguished since any attempt to clear smoke before a fire has been extinguished could introduce more air to the fire. Dedicated fixed smoke clearance trunking is to be of steel construction and both this and the fans are to be capable of operating at the temperatures of the exhaust gas from the extinguished fire but, in any case, not less than 250°C. Portable fans of suitable design may also be used with temperature resistant flexible trunking. Clearance of smoke is to be such that unaffected parts of the ship are not contaminated with smoke.

■ *Section 5*
Testing and trials

5.3 Trials

5.3.1 Trials are to be carried out to demonstrate that the capability of the HVAC systems meets the ~~design statement~~ System Design Description. The trials are as far as practicable to be representative of the actual conditions to be encountered in service.

Volume 2, Part 11, Chapter 3

Waste Systems

Effective Date 1 January 2015

■ *Section 1*
General requirements

1.1 General

~~*1.1.3* The Naval Authority may impose requirements additional to those in this Chapter.~~

~~*1.1.4* The requirements of MARPOL Annex IV and Annex V are to be complied with, unless otherwise agreed by the Naval Authority. Where the Naval Authority opts to not apply MARPOL Annex IV or MARPOL Annex V then this is to be recorded in the tailoring document, *see* Vol 1, Pt 1, Ch 2,3.11.~~

1.3 ~~Plans and information~~ Documentation required for design review

1.3.2 **~~Design statement.~~ System Design Description**. A ~~design statement~~ System Design Description of the waste systems, *see* Pt 1, ~~Ch 2,3.2.2(c)~~ Ch 2,3.5.

■ *Section 2*
Construction and installation

2.3 Piping and equipment – Selection and installation

2.3.1 Pressurised tanks are to be in accordance with Pt 8, Ch 2 or a recognised code ~~satisfy the Naval Authority's revalidation system for such items where applicable~~.

2.5 Coating of storage tanks and piping internal surfaces

2.5.2 Corrosion control coatings are to be tested and certified as complying with standards specified by the Designer and ~~agreed by the Naval Authority~~ Owner.

■ *Section 4*
Treatment of solid waste matter

4.1 General

~~*4.1.1* Disposal of solid waste is to be in accordance with MARPOL Annex V.~~

Existing paragraphs 4.1.2 *to* 4.1.11 *have been renumbered* 4.1.1 *to* 4.1.10.

■ *Section 6*
Testing and trials

6.3 Trials

6.3.1 Trials are to be carried out to demonstrate that the capability of the waste systems ~~meet~~ meets the ~~design statement~~ System Design Description. The trials are as far as practicable to be representative of the actual conditions to be encountered in service.

Volume 2, Part 12, Chapter 1
Emissions Abatement Plant for Combustion Machinery

Effective Date 1 January 2015

■ *Section 9*
Electrical and control equipment

9.1 General

9.1.7 The E-Stop function is to be capable of being actuated from the machinery control room, the navigating bridge and from within compartments containing ~~chemical tanks and~~ exhaust gas cleaning plant. In order to mitigate the risk of chemical release, spaces containing chemical storage tanks or chemical pumping equipment are to have an emergency stop which is to shut down the chemical supply to the emissions abatement plant. Other parts of the emissions abatement plant such as wash water pumps need only be stopped by this emergency stop where loss of chemical injection could result in further risks arising from operating the plant without chemical injection. This is to form part of the submission required in 3.1.6.

(*Part only shown*)

Table 1.9.1 Machinery emissions to air abatement plant: alarms and safeguards

Item	Alarm	Note
~~Wet emissions abatement unit water temperature~~	~~High~~	
~~Chemical feed flow~~	~~High~~	

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